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ANALYSIS OF SIX ISSUES ABOUT NUCLEAR CAPABILITIES OF INDIA, IRAQ, LIBYA, AND PAKISTAN

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OF THE

COMMITTEE ON FOREIGN RELATIONS

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LETTER OF TRANSMITTAL

U.S. SENATE,
COMMITTEE ON FOREIGN RELATIONS,
Washington, D.C., January 15, 1982.

Hon. CHARLES H. PERCY,
Chairman, Committee on Foreign Relations,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: At the request of Senator Cranston and myself, Dr. Warren H. Donnelly and his staff in the Congressional Research Service prepared the studies of the nuclear activities of India, Iraq, Libya and Pakistan.

I herewith submit that study as a report to the Committee on Foreign Relations, pursuant to the rules of the Committee.

Sincerely,

LARRY PRESSLER,
Chairman, Subcommittee on Arms Control, Oceans, International Operations and Environment.

PREFACE

On March 30, 1981, Senators Alan Cranston and Larry Pressler requested the Congressional Research Service to analyze the following six issues:

1. The status of the nuclear programs of India, Iraq, Libya and Pakistan including reactor types, research facilities and technology sources;
2. Published statements from these governments' officials regarding the direction and purpose of their programs;
3. An analysis of the potential for attaining nuclear weapons capability possessed by each nation;
4. The source countries which supply India, Libya and Pakistan and the extent of reliance by these supplier nations upon the United States for nuclear fuel;
5. Potential alternative suppliers of nuclear fuel and technology to these [supplier] countries;
6. The applicability of section 129 of the Atomic Energy Act and the conditions for triggering a moratorium of U.S. nuclear supply to nations assisting other countries in activities "having direct significance for the manufacture or acquisition of nuclear explosive devices."

The following analysis has drawn broadly upon the resources of the Congressional Research Service. It includes work by Mark Louis Wolfe, an analyst in the Education and Public Welfare Division; Richard P. Cronin, an analyst in the Foreign Affairs and National Defense Division; Ray Celada, Senior Specialist; Warren H. Donnelly, Senior Specialist, and Joseph Pilat, his research assistant.

The analysis is based upon information in publications received by the Congressional Research Service, but not upon intelligence information. So while the analysis can provide a point of departure for consideration of the nuclear weapons capabilities of these four countries, its conclusions might be affected and perhaps changed by intelligence information.

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ISSUE I: ANALYZE THE STATUS OF THE NUCLEAR PROGRAMS OF INDIA, IRAQ, LIBYA AND PAKISTAN, INCLUDING REACTOR TYPES, RESEARCH FACILITIES AND TECHNOLOGY SOURCES

To indicate the state of nuclear programs of India, Iraq, Libya and Pakistan, the following information is presented for each: Types of reactors, use of nuclear power, nuclear research facilities, sources of nuclear technology and other resources for nuclear power.

India

TYPES OF REACTORS

Research reactors.—India has five research reactors of various types and one fast breeder test reactor built or under construction (table I). They range in power output from less than 1 megawatt thermal energy to 100 MWt. Fuels used include natural uranium, enriched uranium and plutonium. Moderators include natural and heavy water.

Power reactors.—Except for two boiling water type reactors fueled with low enriched uranium, all of India's nuclear power reactors in operation or under construction are of the pressurized, heavy water moderated type (PHWR) fueled with natural uranium.

INDIA'S USE OF NUCLEAR POWER

Status of commercial nuclear power generation.—As of December 1980, India had three nuclear powerplants in commercial operation and another five in various stages of construction. The total electrical generating capacity will be 1,684 megawatts (MWe) if all are finished and in operation, which is presently expected by the end of 1984. Note that while the first three nuclear power reactors were imported from the United States and Canada, the remaining five are being built by Indian engineers and industry. The Indian Government has chosen the pressurized heavy water reactor (PHWR) of the type pioneered by Canada. Because its fuel is natural uranium, India does not need an enrichment capacity. On the other hand, this type reactor requires heavy water, which is difficult and expensive to produce.

Although behind original schedules, India is well on its way to an independent capability to design, build and operate nuclear powerplants and associated industrial facilities.[1] Its current nuclear power program, if carried out, would make India a leader among developing nations, giving it more nuclear power than Argentina, Brazil, or Yugoslavia, although less than South Korea, Taiwan and South Africa. In addition, India is working to develop breeder reactors which, if successful, could convert thorium into the nuclear fuel

[1] These industrial facilities include factories for manufacture of reactors, nuclear fuel materials, and fabricated nuclear fuel.

uranium-233. India has abundant thorium resources. Details of India's nuclear power capacity appear in table II.

From time to time, Indian nuclear leaders have speculated that India could export small nuclear powerplants which would be more suitable for needs of other developing countries than the large nuclear powerplants now marketed by the major nuclear supplier countries because they would not require massive power grids.

For background, the United Nations has estimated India's electrical generating capacity at 28,140 megawatts which produced 113 billion kilowatt hours in 1979. In other words, nuclear facilities now supply about 2 percent of India's electrical power and will constitute perhaps 4 percent in 1984.

TABLE I.—RESEARCH REACTORS IN INDIA

Unit	Fuel, moderator	Power output (megawatts)	Operating date	Pu_{239} per year (kilograms)	Notes
APSARA	HEU, water	1	1956		Isotope production and physics.
CIRUS	NU, heavy water	40	1960	9.4	High flux test reactor.
Zerlina	NU, heavy water	(?)	1961		Study of reactor concepts.
Purina	Pu, none	0	1972		Zero energy fast reactor.
FBTR	Pu, Th; none	50	C		Fast breeder test reactor.
R-5	NU, heavy water	100	C	23.4	High flux reactor.

Abbreviations:
NU=natural uranium.
HEU=highly enriched uranium.
Pu=plutonium.
Th=thorium.
C=under construction.

Sources: U.S. Congress. Office of Technology Assessment. Nuclear proliferation and safeguards. Appendix vol. II, Pt. I, June 1977, table B-1, p. 229; Indian Department of Atomic Energy, Annual Report 1978-79. Text in worldwide report: Nuclear development and proliferation. [Foreign Broadcast Information Service], No. 41, Apr. 30, 1980.; Octave J. DuTemple, Nuclear Power, February 1981, pp. 64-66.

TABLE II.—NUCLEAR POWERPLANTS IN INDIA

Unit	Type: Power output (net MWe)	Type: Reactor supplier	Architect engineer	Constructor	Completion (percent)	Date of Commercial operation	Total generation (through March 1981) (Twh)	Plutonium-239 contained in spent fuel to date (kg)
Tarapur 1 (Bombay)	200, BWR	GE	Bechtel	Bechtel	100	10/69	10.6	[1] 445.0
Tarapur 2 (Bombay)	200, BWR	GE	Bechtel	Bechtel	100	10/69	10.8	[1] 454.0
RAPP 1 (Kota)	202, PHWR	CGE	AECL/ MECO.	AECL/ MECO HCC.	100	12/73	5.7	[2] 239.0
RAPP 2	202, PHWR	L&T	AECL/ MECO.	HCC	100	81	.2	[2] 8.4
MAPP 1 (Kalpakkam)	220, PHWR	L&T	DAE	ECC	92	83		
MAPP 2 (kalpakkam)	220, PHWR	L&T	DAE	ECC	63	82		
NAPP 1 (Narora)	220, PHWR	WIL	DAE	HCC	28	83		
NAPP 2 (Narora)	220 PHWR	R&C	DAE	HCC	18	84		

[1] Based on NASAP figure of 180 kg plutonium-239 discharged per year per gigawatt electrical capacity from a boiling water reactor.
[2] Based on NASAP figure of 361 kg plutonium-239 discharged per year per gigawatt electrical capacity from a heavy water, natural uranium reactor.

Abbreviations:
AECL=Atomic Energy of Canada, Ltd.
BWR=Boiling water reactor.
CGE=Canadian General Electric Co.
DAE=Department of Atomic Energy, India.
ECC=English Electric Co., Ltd. (Canada).
GE=General Electric Co.
HCC=Hindustan Construction Co.
L&T=Larson & Toubro (India).
MECO=Montreal Engineering Co. (Canada).
MWe=Megawatts electrical (1 GWe = 1,000 MWe).
PHWR=Pressurized heavy water reactor.
R&C=Richardson & Cruddas (India).
Twh=Trillion (10^{12}) watthours.
WIL=Walchandnagar Industries, Ltd. (India).

Sources: World list of nuclear powerplants, Nuclear News, February 1981; nuclear electricity generating table, Nucleonics Week, Apr. 30, 1981.

India's nuclear power strategy.—According to a principal Indian nuclear official, Dr. H. N. Sethna,[2] India's strategy for nuclear power development envisages the construction of natural uranium fueled reactors in its first phase, to be followed in a second phase by fast breeders fueled with plutonium produced by the first phase reactors. Eventually this will lead to a self-sustaining thorium-uranium nuclear fuel cycle. As seen by Dr. Sethna,[3] India is:

> Among the few countries continuing with the development of natural uranium fueled reactors not only because of our preference for a reactor system which can be operated on indigenous resources and technology but also because the uranium utilization is more efficient and larger quantities of plutonium can be produced in such reactors.

NUCLEAR RESEARCH FACILITIES

India's two principal nuclear research facilities are the Bhabha Atomic Research Center at Trombay, near Bombay, and the Reactor Research Center at Kalapakkam, near Madras. Both are part of the Indian Department of Atomic Energy.

Established in 1954, research and development at the Bhabha center includes radioisotope production and use, biology and agriculture, desalination, biochemistry, radiation medicine, medicine, health physics, and the biological effects of high background radiation. Research and development more closely related to nuclear power includes nuclear physics and solid state physics, chemistry, analytical chemistry, radiochemistry, metallurgy, radiometallurgy, special materials, reactor control, reactor chemistry, reactor engineering, fuel repocessing, waste management electronics, reliability, evaluation, seismology, instrumentation, lasers, and radiation protection. The major reactors at this center include the Cirus reactor now in operation and the R–5 reactor under construction. Cirus is a 40-MWt reactor fueled with natural-uranium with heavy water as a moderator. Built in 1956 with Canadian collaboration, it became critical in 1960. Initially the reactor used uranium from Canada and heavy water from the United States. OTA estimated Cirus can produce 9.4 kilograms of plutonium a year. It is generally understood that Cirus provided the plutonium for India's nuclear test in 1974. The R–5 is a larger test reactor of 100 MWt capacity presently under construction at Trombay. It is to be fueled with natural uranium and moderated with heavy water. Its stated use is the production of isotopes and the development of power reactor technology. In research reactors India today appears to be entirely self-reliant.

The Reactor Research Center was established at Kalpakkam to carry out research and development on all aspects of breeder technology. It is a key part of India's long term nuclear power strategy. A Fast Breeder Test Reactor with an electrical generating capacity of 15 MWe and associated facilities is under construction at the center and is being built in collaboration with France, with major parts fabricated locally.

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[2] Chairman of the Indian Atomic Energy Commission and Secretary to the Indian Department of Atomic Energy.

[3] H. N. Sethna Article in the Patriot, Mar. 30, 1980, as reprinted in Worldwide report: nuclear development and proliferation. [Foreign Broadcast Information Service.] No. 44, May 14, 1980, p. 9.

SOURCES OF NUCLEAR TECHNOLOGY

Domestic sources.—In the development of advanced industrial technologies, such as steel and fertilizer production, India's practice has been to import technology and equipment for initial use and later to train its own people to operate and maintain the facilities. For nuclear power however, India has chosen the slower and harder path of self reliance. According to Dr. Sethna, the strategy of India's nuclear program is to build a cadre of scientists and engineers in its research and development institutions. When India has resorted to nuclear imports, it has done so selectively with much of the ground work done by Indians and with the fullest participation of its own people not only to assimilate the new technology but also to adapt it to India's conditions and to improve upon it. By 1980, India had progressed enough to say it had a domestic "know how" and industrial base needed to design, construct and operate nuclear facilities and powerplants, including those for uranium mining and refining, fuel fabrication, heavy water production, reactor construction, reprocessing and waste disposal.[4]

The focal point for Indian nuclear science and technology is the Bhabha Atomic Research Center, mentioned earlier. Subsequently the Indian Department of Atomic Energy was established to take technology from BARC and apply it to commercial scale operations. In addition, three public sector companies were established which are sources of practical working experience with several technologies related to nuclear power. These include Indian Rare Earths, Ltd., The Electronics Corporation of India, Ltd., and the Uranium Corporation of India Ltd. IRE operates the Indian mineral sands industry, which produces thorium products; ECIL manufactures nuclear and non-nuclear electronic instruments and equipment; and UCIL develops uranium mines and operates a uranium mill. Several private firms are also sources of practical working experience with design and construction of nuclear powerplants. These include the Hindustan Construction Co. which is constructor for four nuclear powerplants, Larson & Toubro which is the reactor supplier for three of India's nuclear powerplants, and Richardson and Cruddas, and Walchandnagar Industries Ltd., which have supplied one each. Despite the nuclear advancement the very existence of these companies suggests, the Nuclear Buyers Guide for 1981 [5] does not list a single Indian company in its directory of suppliers.

Foreign sources.—Despite its emphasis on self-reliance, India has received technical assistance from many countries beginning with the United States and Canada in the 1950's. France and West Germany have helped with India's construction of heavy water plants, and France is helping India's breeder program. India also has agreements for nuclear cooperation with Yugoslavia and the Soviet Union. Most recently, India was an active participant in the International Nuclear Fuel Cycle Evaluation (INFCE) which provided it with much updated technological information about various parts of the nuclear fuel cycle.

[4] Sethna, op. cit., p. 9.
[5] Published by the American Nuclear Society in March 1981.

OTHER RESOURCES FOR NUCLEAR POWER

Nuclear materials.—While India's uranium reserves are limited, its thorium reserves are among the largest in the world, which is the reason for India's interest in the thorium fuel cycle. As reported in INFCE, India has about 30,000 tonnes of uranium reasonably assured at $80 per kilogram, another 30,000 tonnes at $130/kg, with about 24,000 tonnes additional estimated at $130/kg.[6] The estimated annual production capability reported in INFCE is about 270 tonnes for 1980 and 230 tonnes for 1985.[7] In comparison, the world total reasonably assured uranium was 1.8 million tonnes at $80/kg plus almost 2.6 million tonnes at $130/kg. As for thorium, of a world total of 1,073,000 tonnes of reasonably assured resources, India accounted for 319,000.[8]

The plutonium contained in spent fuel discharged from India's nuclear power reactors can also be considered as a potential resource. The International Nuclear Fuel Cycle Evaluation in February 1980 estimated that fissile plutonium content of cumulative spent fuel arising in India at 3.45 metric tons by 1985, 7.25 by 1990 and 36.49 by 2000.[9] Since India was an active participant in INFCE, presumably it agrees to these figures.

Nuclear industrial capabilities.—While India has no enrichment plants, it has two spent fuel reprocessing plants and four heavy water plants, as well as factories capable of producing much of the materials and equipment required for nuclear powerplants and their supporting facilities.

India's first reprocessing plant was built at Trombay in 4 years by Indian engineers and technicians using Indian technology. This plant, with a capacity of 20 tonnes per year, was commissioned in 1964 and was intended primarily to reprocess the comparatively simple spent fuel from the Cirus reactor. Later it was shut down, partially decommissioned, and decontaminated so that additions and alterations could be made to expand its capacity and extend its life.[10] Based on this experience, India built a 100 tonne per year reprocessing plant (PREFRE) at Tarapur to reprocess the more complicated spent fuel from the Tarapur reactors which for chemical reasons is more difficult to process. A third plant has been designed for location at Kaipakkam which would also reprocess spent fuel from the fast breeder test reactor. Apparently India plans to build additional reprocessing plants with capacities of 100–200 tonnes per year as they are needed. India claims it can build these plants indigenously at a low cost, thereby making reprocessing economical.[11]

As for heavy water, the Indian Department of Atomic Energy has four commercial scale plants, which are located at Baroda, Kota, Talcher and Titicorin. Table III gives details. Operation of these plants has been uncertain and India has had to import heavy water from the Soviet Union to start up its first heavy water moderated

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[6] Fuel and heavy water availability. Report of Working Group 1. International Nuclear Fuel Cycle Evaluation. Vienna: International Atomic Energy Agency, 1980, p. 154.
[7] Ibid., p. 180.
[8] Ibid., p. 198.
[9] INFCE. Report of Working Group 4. op. cit., p. 268.
[10] Du Temple, op. cit., p. 66.
[11] Ibid.

nuclear powerplant. In addition, it has been reported recently, that the Central Government had approved a proposal to establish a heavy water plant at Manuguru.[12] India's difficulties notwithstanding, its scientists and engineers are now confident of being able to build future heavy water plants without foreign assistance.[13]

The Nuclear Fuel Complex of the Department at Hyderabad also has notable nuclear capability. Its Fuels Group produces zirconium oxide and sponge, fabricates zirconium, and fabricates enriched uranium into fuel. The Tubes Group produces stainless steel tubing for cooling systems.

As part of its drive for nuclear independence, India established four public sector corporations that produce many of the materials, supplies and parts needed for nuclear powerplants. As noted earlier, these companies produce thorium, uranium ores and feed materials, and electronics equipment. In addition, the Department of Atomic Energy has attempted to share its knowhow and experience with Indian industry, which has resulted in the manufacture of many nuclear components and also improvement in quality of conventional components.[14]

TABLE III.—INDIAN HEAVY WATER PRODUCTION CAPACITY

Plant and process	Capacity (Metric tons per year)	Starting date
Nangal: Electrolysis-hydrogen distillation	14	1962
Baroda: Monothermal hydrogen-ammonia exchange	67	1977
Titicorin: Monothermal hydrogen-ammonia exchange	71	1978
Talcher: Bithermal hydrogen-ammonia exchange	63	[1] 1979
Kota: GS	100	[1] 1979

[1] In January 1981 it was reported that these dates had slipped to mid-1981 and late-1981 respectively. (Nuclear Engineering International, January 1981, p. 5.)

Source: INFCE, Report of Working Group 1, op. cit., p. 226

Technical education.—India sees itself as having the third largest pool of scientific and technical manpower in the world.[15] It has many institutions to train in science and technology including colleges, universities, and all-India educational or research institutions. In 1979 India had 108 universities, 9 institutions of national importance and 10 institutions deemed as universities. For training high-level engineers and technologists, five Institutes of Technology, an Indian Institute of Science in Bangalore, and 89 other institutions offer post graduate and research courses.[16]

Iraq

TYPES OF REACTORS

Research reactors.—Iraq has a small pool type research reactor which went critical in January 1968. Until the Israeli attack of June 7, 1981, Iraq also had a more powerful research reactor with a thermal

[12] The Hindu (Madras), June 24, 1981, p. 1. Text in Worldwide report: nuclear development and proliferation, No. 197, July 30, 1981, p. 3.
[13] Nuclear Engineering International, July 1981, p. 27.
[14] Annual report 1978–79, Indian Department of Atomic Energy, op. cit., p. 3.
[15] H. N. Sethna, op. cit., p. 8.
[16] Statesmen's Yearbook, 1980–81, p. 623.

power output of 40 MW almost ready to start up and an associated critical assembly for this reactor.

Power reactors.—Iraq has no power reactors.

IRAQ'S USE OF NUCLEAR POWER

Iraq has no nuclear powerplants in operation or under construction. It was reported to be interested in a 960 MWe PWR nuclear powerplant to be supplied by the French Company, Framatome. However, a recent news report indicates that negotiations between Framatome and Iraq were broken off because Iraq was concerned more with buying Mirage fighters and artillery than a nuclear powerplant.[17] Iraq also has shown some interest in a natural uranium fueled power reactor of Italian design.

NUCLEAR RESEARCH FACILITIES

Iraq has one small research reactor in operation. It is a tank type fueled with enriched uranium of various enrichments including 10 percent, 36 percent and 80 percent. It has a thermal power output of 2 megawatts. In theory it could produce about 38 grams of plutonium annually. It was furnished by the Soviet Union and became operable in 1967. A second, more powerful reactor, known as Tammuz-1, was nearing completion when it was heavily damaged by Israel's bombing of June 7, 1981. This reactor was the target of an earlier bombing attempt, presumably by Iran, on September 30, 1980. It was to be fueled with highly enriched uranium (93 percent). With a planned thermal power output of 40 megawatts, it was identical in design to the French Osiris research reactor at Saclay.[18] France furnished the reactor, was completing its installation, and had contracted to supply an initial four fuel loadings totalling about 72 kilograms of highly enriched uranium.

Because of the proliferation risks of highly enriched uranium, in 1977, French President Giscard d'Estaing announced that France would substitute a fuel of much lower enrichment (6 percent), the "caramel" fuel, which could not be used directly to make nuclear explosives. However, France abandoned this idea for Iraq's reactor in February 1980, announcing this decision at the plenary session of the International Nuclear Fuel Cycle Evaluation.

An initial quantity of fuel, containing about 12 kilograms of 93 percent enriched uranium was delivered in June 1980 and inspected upon arrival. It was again inspected in January 1981 and found to be intact. The IAEA attempted to inspect the fuel after the Israeli attack but were not able to approach the damaged facility because of suspected unexploded bombs and the extent of the damage. The inspectors requested Iraq to submit a special report and to keep IAEA informed on clearing of the reactor site. Iraqi authorities agreed that inspection will be resumed as soon as the reactors and the fuel storage are physically accessible.

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[17] Nucleonics Week, Feb. 19, 1981, p. 2.

[18] The Saclay reactor has a power output of 70 MW. According to the French nuclear attaché at the French Embassy in Washington, the Iraq unit would have been limited to 40 MW because the heat removal system would not work as well in Iraq's climate.

At the time of writing, France and Iraq had agreed to open talks in Paris in mid August on reconstruction of the reactor.[19] Saudi Arabia had previously offered to finance the rebuilding.[20]

The reactor was located at Iraq's nuclear research center at Tuwaitha, near Baghdad. The center is being built by France under an agreement signed following the oil production restrictions and embargo of the Arab oil producers in 1973–1974. In addition to research reactors, the center also includes nuclear laboratory equipment supplied by Italy. One controversial item is a "hot-cell" which some think might enable Iraq to extract plutonium from irradiated uranium. We were unable to find detailed information about this item. The center has been described as a "nuclear university" capable of training 600 nuclear scientists and engineers at one time. What the future of the center will be now that the research reactor has been bombed remains to be seen.

SOURCES OF NUCLEAR TECHNOLOGY

Iraq has few native sources of nuclear technology. While it has established a National Nuclear Energy Organization[21] and its Tuwaitha nuclear research center is nearing completion, there appear to be no other internal sources for Iraq to develop independently and apply nuclear technology. So Iraq has to seek foreign assistance. France is Iraq's principal supplier based on agreement for nuclear cooperation signed in November 1975.

In the past, Iraq has sent scientists and technologists to the U.S. Atomic Energy Commission's International School of Nuclear Science and Engineering. For example, the AEC reports that the seventh session of this school in 1958 mentioned five students from Iraq.[22] Similarly, AEC figures indicate that 24 Iraqi scientists took part in research at AEC facilities from 1955 to 1976.[23]

Iraq can also obtain technical assistance from the International Atomic Energy Agency. It has had the advantage of the open proceedings of four United Nations International Conferences on the peaceful uses of nuclear energy to which the United States and other countries contributed many technical papers covering virtually every aspect of the nuclear fuel cycle.

Iraq also apparently has looked to Brazil for nuclear assistance. On January 8, 1980, these two governments reportedly signed an agreement for cooperation which provides for transfer to Iraq of technology on the exploration and treatment of uranium, equipment, construction of reactors, installation safety, and personnel training, subject to the restrictions contained in the 1976 agreement between Brazil and the Federal Republic of Germany.[24]

[19] The Wall Street Journal, Aug. 10, 1981, p. 15.

[20] David B. Ottoway, Saudis offer financing for Iraqi reactor, Washington Post, July 17, 1981, p. A1, A18. See also Wall Street Journal, July 17, 1980, p. 30.

[21] Iraq earlier established an Atomic Energy Commission in 1956 which was one of the first in the Middle East.

[22] U.S. Atomic Energy Commission, Atomic industrial progress and second world conference, July–December 1958, p. 177.

[23] U.S. Congress, Joint Committee on Atomic Energy, S. 1439 Export Reorganization Act of 1976, Hearing, June 22, 1976, 94th Congress, 2d session, p. 463.

[24] Oestado de Sao Paulo (Sao Paulo), Jan. 25, 1980, p. 5. Text in Worldwide report: nuclear development and proliferation, No. 33, Mar. 4, 1980, pp. 5–6. See also Oestado de Sao Paulo, Jan. 9, 1980, p. 6, and Jan. 11, 1980, p. 5. Text in Worldwide report: nuclear development and proliferation, No. 29, Feb. 13, 1980, pp. 26–28.

According to the British publication, New Scientist, Iraq in 1980 also concluded a nuclear agreement with Portugal for the supply of enriched uranium and a confidential agreement with Spain for unspecified nuclear assistance.[25]

OTHER RESOURCES FOR NUCLEAR POWER

Although uranium is widely distributed, Iraq does not have enough to be listed in the world estimates for uranium cited by the International Nuclear Fuel Cycle Evaluation Working Group I in its report of February 1980. Also, Iraq has no established nuclear industry to produce, refine and use uranium, to manufacture nuclear reactors, to enrich uranium, or to recover plutonium from spent fuel. The controversial Italian hot cells could enable it to separate some plutonium from irradiated uranium. Iraq lacks chemical, metallurgical and electrical and electronics manufacturing industries needed to establish a nuclear industry. It does have a steel industry and a cement industry.

As for universities, there were six in Iraq in 1977 with about 72,000 students. Iraq's nuclear community, however, has been reported to lack motivation to work. Distrust among colleagues because of numerous arrests, imprisonments and executions has been demoralizing.[26]

LIBYA

TYPES OF REACTORS

Libya has one 10 MW research reactor under construction. It has no power reactors in operation or in construction. Its research reactor is an upgraded Soviet type to be fueled with highly enriched uranium. Prolonged negotiations with the Soviet Union and Finland may culminate in construction of a standard 440 MWe nuclear powerplant of Soviet design as adapted to use in Finland, which would be fueled with slightly enriched uranium.

LIBYA'S USE OF NUCLEAR POWER

As noted above, Libya has no nuclear powerplants in operation or under construction. The planned nuclear powerplant would supply some of the electricity in the vicinity of Tripoli, the national capital.

NUCLEAR RESEARCH FACILITIES

Libya has no nuclear research facilities in being. However, the Soviet Union and Libya reportedly signed an agreement on May 30, 1975 to establish a nuclear center for peaceful purposes in Libya, which would include a research reactor.[27] There is little detail about the purpose or status of this center in the open literature, particularly what kind of laboratory equipment it might have capable of recovering plutonium from uranium irradiated in the research reactor.

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[25] New Scientist, Aug. 28, 1980, p. 635.
[26] Ibid.
[27] Richard L. Holman, Libya to get Soviet Built nuclear plant, The Washington Post, June 3, 1975, p. A–1.

SOURCES OF NUCLEAR TECHNOLOGY

Domestic sources.—Libya has little of an educational, scientific and industrial base to independently develop and manufacture nuclear explosives. If the Soviet Union completes the research center and, assuming that Libya can arrange for competent staff, then Libya could begin training nuclear scientists, engineers and technicians. In a 1975 interview, Qadhafi said he planned to entice Arab scientists away from the United States and other Western countries to make Libya a nuclear power, and that Libya had begun to offer such scientists lucrative contracts to move to Libya.[28, 29] Subsequently, in 1979, a former CIA analyst said that in 1975 Qadhafi had ordered PLO leader Yasir Arafat to assemble a group of Arab scientists to make an atomic bomb, but that Arafat dared not tell him there were none sufficiently trained to do so.[30]

In January 1981, Libya established a new Ministry for Atomic Energy with a close Qadhafi associate, Obdul Magid el-Mabruk el-Gaud, in charge.

Foreign sources.—From news reports, it appears that Libya is obtaining nuclear technical assistance from the Soviet Union and has tried to get some from France and from India.

As noted earlier, the Soviet Union is helping Libya to establish a nuclear research center complete with a 10 MW reactor, and there have been reports of Libyan negotiations with the Soviet Union for one or two nuclear powerplants. In 1977, the Washington Post reported that Libya had contracted with the Soviet Union for construction of a 440 megawatt nuclear powerplant, but that no announcement was made by either country. Presumably Finland was to design and construct an emergency core cooling system to be added to a standard Soviet export power reactor. The estimated cost of the plant was $330 million.[31] Almost a year later, a Soviet nuclear official said in Paris that the Soviet Union had signed an agreement with Libya to provide a nuclear power complex including a nuclear powerplant, a research center, and laboratories.[32] Still more recently, the Arab language news weekly, Al-Mustaqbal, was quoted as reporting on March 23, 1981 that Qadhafi was to sign an agreement with the Soviet Union during a forthcoming trip to the Soviet Union on the installation of a nuclear research center in Libya.[33] The most recent news of Libya-Soviet nuclear cooperation came in May 1981 with report of an agreement at the end of Qadhafi's visit to Moscow. A Soviet statement said that "The Soviet Union reiterated its readiness to participate in the nuclear research center which had been built with Soviet assistance." Libyan sources in Moscow said that the center was not yet finished, but the question of Soviet participation would arise when it begins operation. Also, Tass reported that the question of the construction of an 800

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[28] The New York Times, Jan. 14, 1975, p. 8.

[29] The IEEE Spectrum of May 1980 carried a full page advertisement for academicians for the Department of Electronic and Computer Science, Materials Science and Engineering, and Nuclear Engineering and Technology for Al-Fatah University.

[30] Attributed to Cord Meyer, former CIA official and a columnist for the Washington Star. The New York Times, Apr. 16, 1979, p. A9.

[31] Thomas O'Toole, Libya said to buy Soviet A-powerplant. The Washington Post, Dec. 12, 1977.

[32] The Washington Post, Oct. 4, 1978.

[33] Cited in Worldwide report: nuclear development and proliferation, No. 91, Apr. 15, 1981, p. 3.

MWe nuclear powerplant as well as thermal power stations and new power supply lines were being studied. The reference to 800 MWe is believed to refer to two standard 440 MWe Soviet export power reactors. This was the third Soviet-Libyan meeting on the question of nuclear reactors.[34]

Libya also has looked to France for assistance, apparently with little success. On March 22, 1976, it was reported that Libya had signed an agreement with France at the end of a visit to Tripoli by then French Prime Minister Chirac. One account says the agreement covered a 660 MWe nuclear powerplant. The French reportedly made it clear that they would not provide Libya with nuclear research facilities or the means to produce heavy water.[35] Another account described it as a research reactor.[36]

Libya also has tried to get nuclear power assistance from the United States. AEC chairman Dixie L. Ray said that in 1974 Libya had approached the General Atomics Corporation for such assistance, but that the deal had been opposed by the State Department and the Congressional Joint Committee on Atomic Energy.[37]

Libya also has sought nuclear assistance from India and, if reports are correct, has tried to use pressure of oil supply to get additional, but unspecified, Indian assistance. An agreement for nuclear cooperation was signed between the two states in July 1978 during a visit to New Delhi of Libyan Prime Minister Jalloud, who reported pressed hard for an Indian promise to help Libya acquire an independent nuclear capability. The head of the Libyan Atomic Energy Agency, who was present, discussed the matter with his Indian counterpart, Dr. H. N. Sethna. At this time Sethna reportedly said it was beyond the capacity of Libya to obtain nuclear capability within the foreseeable future. The Indo-Libyan agreement provided for nuclear training and presumably reflected Indian policy of offering limited assistance to all friendly countries in peaceful uses of the atom through training at Indian nuclear establishments either via bilateral arrangements or under the auspices of the IAEA's technical assistance program. This Indian training did not extend to nuclear explosives. Also, Libya was informed that India would not agree to any linkage between oil supplies and nuclear cooperation.[38]

Nevertheless, on August 28, 1979, the Times of India and the Hindu reported that Libya's dissatisfaction with the limited scope of the nuclear cooperation agreement lay behind its suspension of oil deliveries to India. According to the Hindu, "The Qadhafi regime has evidently thought that with a little bit of arm twisting, India could be persuaded to take a less rigid view of its policy of not transferring its nuclear technology." A Libyan diplomat characterized his government's moves as a "friendly nudge."[39] The Times of India observed that Libya's idea of cooperation was perhaps in applied nuclear technology, which India did not intend to develop. India had to be particularly careful, said the Times, about nuclear cooperation when

[34] Nucleonics Week, May 7, 1981, p. 5–6.
[35] The New York Times, Mar. 23, 1976, p. 9.
[36] The Economist, Mar. 27, 1976, p. 52.
[37] The New York Times, June 4, 1975, p. 16.
[38] Nuclear Engineering International, November 1970, pp. 7–8.
[39] Reported in the Kuala Lumpur Business Times, Aug. 30, 1979, p. 3. In Worldwide report : nuclear development and proliferation, No. 16, Oct. 31, 1979, p. 17.

there is a worldwide scare about the proliferation of nuclear technology.[40]

Libya also in 1980 had 25 senior students from Al-Fatah University at Finland's National Technical Research Center for a course on nuclear technology. The Libyans reportedly were there to learn about the peaceful uses of nuclear power, and electrical and nuclear technology.[41]

OTHER RESOURCES FOR NUCLEAR POWER

Nuclear materials.—While uranium is widely dispersed in the Earth's surface, public information indicates few concentrated deposits in Libya. The report of INFCE Working Group I on nuclear fuel availability did not list Libya among the nations with uranium resources.

Nonetheless, Libya reportedly got Argentina to agree in 1974 to provide it with scientific equipment to prospect for radioactive materials (uranium), and to train Libyan chemists in uranium extraction and purification.[42]

Libya's interest in Chad is attributed in part to its desire to get at uranium believed to be there.[43] The Sunday Times (London) linked this with Qadhafi's announcement in April 1975 that Libya was preparing to become a nuclear state.[44]

Niger is reported to have sold 450 metric tons of normal uranium to Libya. Some think part of this may have been diverted to nations suspected to be developing nuclear arms, including Pakistan. The President of Niger in an interview said that his government needed the money badly and once assurances were given that the material would not be used for bombs, his government's responsibility was ended.[45] The Natural Resources Defense Council in Washington was quoted as saying that Pakistan was getting its uranium from Libya.[46] Niger is the world's fourth largest producer of uranium and produces about 4,000 metric tons of uranium oxide annually from two multinationally financed mines near Arit in its northern desert. It reportedly banned uranium shipments to Libya in January 1981 because of Libya's occupation of Chad.[47]

Nuclear industrial capabilities.—Libya appears to have little, if any, industrial capacity to produce nuclear materials or equipment. It has few manufactures other than processing of agricultural products, maintenance and small-scale replacements for vehicles, cement, and small consumer goods. Almost all large manufactured goods are imported from Italy, West Germany, and France. Libya has begun ambitious industrial development aimed at the local manufacture of building materials, steel, aluminum pipes and fittings, electric cables, cement, brick and glass. One indication of Libya's limited industrial capability is its total electricity output which in 1972 was 190 MWe, but increased to 900 MWe by the end of 1979.

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[40] Nucleonics Week, Aug. 30, 1979, p. 10.
[41] Hufvudstadet (Helsinki) Oct. 24, 1980, p. 19. Translated in Worldwide report: nuclear development and proliferation, No. 20, Nov. 14, 1980, p. 35.
[42] The Arab World Weekly (Beirut) Jan. 24, 1981. In Worldwide report: nuclear development and proliferation, No. 84, Mar. 3, 1981, p. 36.
[43] The Washington Post, Sept. 8, 1975, p. A–18.
[44] Ibid.
[45] Journal of Commerce, Apr. 15, 1981, p. 35.
[46] Ibid.
[47] Ibid.

Technical education.—Libya has two universities with some 13,500 students at Al-Fatah (in Tripoli) and Garyounes (in Benghazi).

PAKISTAN

TYPES OF REACTORS

Research reactors.—Pakistan has one research reactor. A pool-type, its power output is 5 MWe and it uses 90 percent enriched uranium.[48]

Power reactors.—Pakistan has one operating reactor which is a pressurized, heavy water reactor (PHWR). There are reports that Pakistan plans to order a large light water type powerplant.[49]

PAKISTAN'S USE OF NUCLEAR POWER

Status of commercial nuclear power generation.—As of December 1980, Pakistan had one operating power reactor, but no others either under construction or on order.[50] The operational reactor, known as KANUPP, is located near Karachi. Supplied by Canadian General Electric, it is of the CANDU variety, fueled with natural uranium and requiring heavy water for its operation. Its electrical generating capacity is 125 MWe. Its operating record has been poor.

There are news reports that a 600–900 MWe nuclear powerplant fueled with low enriched uranium is planned at Chasma. According to Munir Ahmad Khan, the Chairman of the Pakistan Atomic Energy Commission, in January 1980 the "necessary preliminaries . . . have been completed and the actual construction will begin as soon as the difficult financial position becomes easier. This multimillion dollar project has been approved by the Executive Committee of the National Economic Council."[51] Recently a Spanish firm was reported to have received a contract to design this plant with participation of the Pakistan Atomic Energy Commission and a Pakistani engineering company.[52]

The 18-month shutdown of KANUPP in 1979–80 (following the withdrawal of Canadian technicians, and the termination of fuel supplies from Canada), and the financial and other difficulties that have delayed the Chasma project, have put the Pakistani nuclear power program behind schedule. Originally, the conception of the program was quite ambitious. As the Business Times (Kuala Lumpur), described it on Dec. 17, 1979:

> Following the Chasma plant, the country will need one nuclear powerplant every alternate year, letting the share of nuclear power grow from the present 137 MW to 1340 MW in 1985, to 4940 MW in 1990, and to 15,935 MW in 2000, when the total generating capacity is planned to be raised to 26,400 MW.[53]

The early realization of a nuclear program of this scope, or even one more modest, does not appear likely given Pakistan's limited technological capability. Pakistan has yet to demonstrate an independent

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[48] U.S. Congress. Office of Technology Assessment. Nuclear Proliferation and Safeguards. Appendix volume II, part 1, June 1977 Table B–1, p. 229.
[49] Nuclear News, June 1981, p. 91.
[50] World List of Nuclear Power Plants. Nuclear News, February 1981, p. 82.
[51] Munir Ahmad Khan, article in Khyber Mail (Peshawar), Jan. 7, 1980, p. 4. Text in Worldwide report: nuclear development and proliferation, No. 28, Feb. 1, 1980, p. 20.
[52] Nuclear News, June 1981, p. 91.
[53] Text in Worldwide report: nuclear development and proliferation No. 35, Mar. 17, 1980, p. 10.

capability to design and build nuclear powerplants. While it has demonstrated a capacity to restart and operate KANUPP, it is not evident that Pakistan can supply major replacement parts to keep it going.

If Pakistan indeed were to acquire the nuclear power reactors planned and could domestically supply the necessary heavy water, uranium, and fuel fabrication, it would have a self-sufficient nuclear fuel cycle capable of producing comparatively large quantities of high quality plutonium. The cadre of experienced engineers, nuclear technicians and operators thereby created could give Pakistan some ability to export some nuclear technology to other countries. However, Pakistan at present appears far from this goal.

Pakistan's nuclear power strategy.—Pakistan's nuclear power program is run by an Atomic Energy Commission (PAEC), which was created in 1959. Modeled after the former U.S. Atomic Energy Commission, it appears to have ambitious future plans. As has been indicated, Pakistan plans the completion of the 600 MWe Chasma nuclear powerplant, to be followed by "more nuclear powerplants at a much faster rate."[54] According to the PAEC, the need to increase energy consumption, particularly electrical, "is why nuclear energy has special significance and considerable potential in Pakistan."[55]

Although Pakistan's plans contemplate only conventional reactors at present, the Pakistanis have an interest in reprocessing and, eventually, in breeders. According to Khan:

> The central role of a reprocessing plant can be understood from the following facts . . . We can reuse . . . discharged fuel provided we remove the poisonous fission products and clean up the uranium and separate plutonium which is produced in the reactor. A reprocessing plant is used to perform this operation. Its advantages are:
>
> (i) It enables one to recover unburnt uranium which can be reused in new power reactors.
>
> (ii) It yields plutonium which is known appropriate fuel for breeder reactors.
>
> Without plutonium there can be no efficient breeder reactor and without breeders the full potential of nuclear power cannot be realized. . . . It is because of this crucial role of the reprocessing plant that Pakistan is determined to go ahead with this project.[56]

NUCLEAR RESEARCH FACILITIES

Pakistan's principal nuclear research facility is the Pakistan Institute of Science and Technology (PINSTECH) in Nilore, near Rawalpindi. PINSTECH was established in 1965 to implement Pakistan's nuclear power program—specifically, to provide research and training facilities for nuclear scientists and technicians. The 5 MW Pakistani research reactor is located there. PINSTECH is used also to help other PAEC programs.[57] Of the nuclear programs of the PAEC, the only relevant ones that are officially referred to are the educational, agricultural, and medical. PAEC's reactor school established in 1969

[54] Khan, op. cit. p. 20.
[55] International Atomic Energy Agency General Conference, 24th regular session, GC (XXIV)/INF/195, Sept. 23, 1980, p. 2.
[56] Khan, op. cit., p. 20; see also Nuclear Energy in Pakistan (Islamabad: Directorate of Films and Publications, Ministry of Information and Broadcasting, Government of Pakistan, 1979), pp. 9–11.
[57] See Business Times (Kualg Lumpur), Dec. 17, 1979, text in Worldwide report: nuclear development and proliferation, No. 35, Mar. 17, 1980, p. 11.

has evolved into a Center for Nuclear Studies, which provides graduate courses in nuclear engineering. PAEC has also established agricultural centers utilizing nuclear radiation in Faisalbad and Tandojam, and is building the Nuclear Institute for Food and Agriculture at Tarnab, near Peshawar. Moreover, PAEC has established nuclear medical centers at Karachi, Lahore, Multan, Jamsboro, and Peshawar; has completed another at Larkana; and is planning the nation's largest nuclear medical center at Islamabad.[58]

In addition to these various facilities, the Rawalpindi Engineering Research Laboratory has a prominent role in the engineering aspects of Pakistan's nuclear power programs.[59]

SOURCES OF NUCLEAR TECHNOLOGY

Domestic sources.—Following the 1976 recall of Canadian nuclear technicians and the termination of nuclear supplies from Canada, Paskistan embarked upon the path of nuclear self-reliance. Although it has had some successes to date, a high level of domestic nuclear technology has not been demonstrated.

Pakistan is still unable to design and build nuclear powerplants, although, it has demonstrated its ability to restart, fuel, operate, and maintain the KANUPP reactor. Pakistanis reportedly were able to fabricate some replacement parts for the reactor, and to make special alloys for some components,[60] together with some capability to design and build certain associated industrial facilities, including a plant for the indiginous production of nuclear fuel, and additions to a reported heavy water facility.[61] Moreover, although the status of the incomplete large-scale reprocessing plant begun by the French at Chasma is uncertain, Pakistan scientists and technicians reportedly are attempting to construct a small-scale reprocessing plant at PINSTECH.[62] Also Pakistan's attempt to build a gas-centrifuge enrichment facility at Kahuta using foreign designs (perhaps modified) have been reported. The covert acquisition of technology presumed to be used in construction of a centrifuge-type enrichment facility was the basis for the most recent cutoff of certain U.S. military and economic aid to that country in 1979.[63] To the extent these reports are accurate, they indicate a growing Pakistani capacity in nuclear technology.

In the PAEC, Pakistan has an organization to direct research and development of nuclear power. In PINSTECH, it has a relatively sophisticated nuclear research facility. And, in the Centre for Nuclear Studies and the Rawalpindi Engineering Research Laboratory, it has developed supporting educational and engineering institutions. Nevertheless, the country's nuclear facilities and programs are limited. Not only are adequate numbers of scientists and technicians wanting, but the industrial base of Pakistan is limited. To be sure, Pakistan is expanding the capacity of its cement plants; and it has constructed a

[58] Khan, op. cit., p. 21.
[59] See Energy Daily, Sept. 30, 1980, p. 4.
[60] Ziauddin Sardar, "Why the Third World Needs Nuclear Power," New Scientist, Feb. 12, 1981, p. 403.
[61] Ibid.; see also Nature, Sept. 18, 1980, p. 181.
[62] On the small-scale reprocessing project, see Milton Benjamin, "Pakistan Building Secret Nuclear Plant," Washington Post, Sept. 23, 1980, pp. A–1, A–12.
[63] On the enrichment program, see Don Oberdorfer, "U.S. Cutting Aid to Pakistan in A-facility Dispute," Washington Post, Apr. 7, 1979, pp. A–1, A–19.

large steel mill, a heavy mechanical complex, and a heavy forge and foundry plant.[61] But the country has yet to develop the many industries essential to a nuclear power program, including electronics, metallurgy, precision machinery, and chemicals.

As a consequence of the above-mentioned factors there are limits to what one might expect from Pakistan's nuclear program if it were isolated from other countries. For, although Pakistan apparently has shown itself capable of some independent nuclear development, its dependence continues on foreign technology, educational facilities, equipment, and nuclear material. By no means has Pakistan achieved nuclear independence.

Foreign sources.—Pakistan has depended heavily on nuclear technology from abroad. The participation of the U.S. Oak Ridge Nuclear Laboratory with PINSTECH in a "sister laboratories" program involved the United States supply of laboratory parts, equipment, and scientific journals. Of considerably more importance, the United States built and financed a research reactor[62] at a time when it still had an agreement for nuclear cooperation with Pakistan. Canada, of course, supplied Pakistan with the 125 MWe Kanupp reactor, and the heavy water it required. The United States, too, supplied the Pakistanis with heavy water in the past.[63]

More recently, Pakistan is believed to have begun construction of secret reprocessing and enrichment plants that have required the acquisition of sensitive technology equipment and supplies from abroad. Covert purchases of equipment and materials for these projects from foreign suppliers have been reported that include: Electrical inverters from the United Kingdom and Canada; stainless steel vessels from Italy; aluminum rods, vacuum pumps, and a uranium flouridation plant from the Federal Republic of Germany; and vacuum valves and evapovation and condensation systems from Switzerland.[64]

In a recent development of special interest, the Soviet Union reportedly is willing to assist Pakistan nuclear development, which may mean, in effect, a new source of nuclear technology.[65] To date, however, the Soviet Union apparently has been unwilling to transfer nuclear technology unless Pakistan agrees to stringent restrictions and, in effect, Soviet control.

Note too that Pakistan has had the advantage of the open proceedings of the four U.N. conferences on the peaceful uses of nuclear energy and, more recently, of the technological information available through the International Nuclear Fuel Cycle Evaluation.

OTHER RESOURCES FOR NUCLEAR POWER

Nuclear materials.—Pakistan has begun mining uranium in its northern Dera Ghazi Khan district, where significant reserves are be-

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[61] The Statesman's Yearbook, 1980–81, p. 957.

[62] Warren H. Donnelly, Analysis of ERDA Information on U.S. Nuclear Assistance to Pakistan, CRS Memorandum, Dec. 27, 1977, pp. 3, 6–7.

[63] Ibid., pp. 8–9.

[64] See, for example, P.K.S. Namboodiri, Pakistan's Nuclear Posture, In Nuclear myth's and realities, ed. by K. K. Subrahmanyam (New Delhi: ABC Publishing House, 1981), p. 154–194; The Hindu (Madras), June 20, 1980; The Times of India (Bombay), Dec. 31, 1980, pp. 1, 15, (text in Worldwide report); Nuclear development and proliferation, No. 82, pp. 36–38; Energy Daily, Sept. 30, 1980, pp. 3–4; Stern, July 2, 1981, pp. 96–99; and Foreign Report, 1655, June 18, 1980, pp. 2–3.

[65] Nucleonics Week, May 14, 1981, p. 7.

lieved to be located. In the late 1960's, a reserve of 100,000 tons was reportedly revealed, and the fuel for KANUPP appears to have come from domestic uranium.[69] Nevertheless, Pakistan's reserves are not thought to be large. The report of Working Group 1 of INFCE in the section on uranium and thorium reserves does not list Pakistan among the states with "reasonably assured" or "estimated additional" uranium resources.

Available uranium resources need not be domestic. It is reported that Pakistan has received supplies of uranium oxide "yellow cake" directly from Niger, and indirectly from Niger through Libya.[70]

Since plutonium can also be considered as a fuel, the amount of plutonium produced by the KANUPP reactor is of interest. The Department of Energy's NASAP report indicates a reactor of this type and size might produce about 55 kg of total plutonium a year of which 76 percent would be the fissionable isotope Pu-239.[71]

Although Pakistan has indicated an interest in breeders, using this to justify reprocessing, its limited nuclear resources would make independent breeder development a remote possibility.

Nuclear industrial capabilities.—There are unconfirmed reports that Pakistan has some capability to produce heavy water, used primarily to keep KANUPP in operation. Also a 15-ton heavy water plant under construction, or operational, near Multan has been mentioned.[72]

As noted earlier, Pakistan appears to be trying to build reprocessing and gas-centrifuge enrichment facilities, using imported technology and equipment.

The reprocessing plant at PINSTECH could be a scaled-down version of the Chasma reprocessing plant contracted with SGN, a French firm, in 1976. Before the contract was cancelled by the French, construction at the Chasma facility had begun and, reportedly, virtually all of the plans had been delivered.[73] We have no information on its present status. Utilizing a gas-centrifuge process allegedly stolen by a Pakistani scientist employed at the Almelo installation of URENCO, and components purchased surreptitiously from a variety of foreign sources, Pakistan also has been trying to build a uranium enrichment plant. These efforts led to cutoff of U.S. military and economic aid as required by the Symington amendment.

While such facilities could give Pakistan a source of weapons grade materials, it appears unlikely they will soon be completed and suc-

[69] Nature, Sept. 18, 1980, p. 181.

[70] Nuclear News, February 1980, p. 91; Christian Science Monitor, Dec. 19, 1979, p. 4.

[71] U.S. Department of Energy, Nuclear proliferation and civilian nuclear power, Report of the Nonproliferation Alternative Systems Assessment Program, Vol. IX: Reactor and fuel cycle description, June 1980 [Report DOE/NE 0001/9] table B.1, p. B-21.

NASAP data indicates that in normal power operation a heavy water reactor fueled with normal uranium would produce about 361 kilograms of fissionable plutonium (Pu-239) annually as part of a total of about 440 total plutonium per gigawatt of electrical capacity. Since the Kanupp reactor has an electrical output of 125 MWe, or 0.125 GWe, the corresponding plutonium production would be about 44 kilograms of Pu-239 contained in 55 kg total plutonium. Plutonium that is only 76 percent Pu-239 would be unattractive to weapons designers. However, it is feasible to run more uranium through a HWR type reactor for the same power generation to produce a better quality plutonium, i.e. material with less Pu-240.

Note also, the report of INFCE Working Group 4 on Reprocessing, plutonium handling and recycle in 1980 did not list Pakistan in its tables of projections for accumulated of spent fuel and plutonium.

[72] The Patriot (New Delhi), July 2, 1981, p. 1. Text in Worldwide report: nuclear development and proliferation, No. 107, July 30, 1981, p. 4.

[73] Leonard Downie, "U.S. Says Evidence Shows Pakistan Planning A-bomb," Washington Post, Sept. 21, 1980, p. A-20.

cessfully operated. All in all, there is little solid public information to show that Pakistan now has the capacity to independently produce nuclear weapons materials without foreign aid. Moreover, the high costs would be a drain on other social and economic activities.

Technical education.—Pakistan has some capacity for education in nuclear energy. The PAEC's Reactor School, which was established in 1969, is presently the Centre for Nuclear Studies. In conjunction with the Quaid-i-Azam University at Islamabad, the center offers post-graduate nuclear engineering courses. An 18-month program leading to the M.Sc. in nuclear engineering (for which the PAEC provides some scholarships and stipends) is available.[74] Furthermore, there are a variety of colleges and universities in Pakistan, including the open university in Islamabad with 26,000 students and 2,100 teachers.[75]

Although many Pakistani nuclear scientists and technicians have been educated at home and abroad (with some trained in the United States between the mid-1950's and the mid-1970's [76]), Pakistan appears to be short handed. Khan has admitted: "We have the problem of quantity of our technological manpower. Our engineering is very limited." [77]

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[74] Business Times (Kuala Lumpur), Dec. 17, 1979, p. 4. Text in Worldwide report: nuclear development and proliferation, No. 35, Mar. 17, 1980, p. 11.
[75] Statesman's Yearbook, 1980–81, p. 959.
[76] Donnelly, op. cit., pp. 2–3 and tables I and II on pp. 4 and 5. See also Mark Wolfe, "Discussion of Enrollment Data on Foreign Nationals from India and Pakistan in Engineering and Physics Programs in the United States and Western Europe," p. 2.
[77] Khan, op. cit., p. 22.

ISSUE 2: ANALYZE THE PUBLISHED STATEMENTS OF GOVERNMENT OFFICIALS OF INDIA, IRAQ, LIBYA AND PAKISTAN REGARDING THE DIRECTION AND PURPOSE OF THEIR NUCLEAR POWER PROGRAMS

Introduction

Two principal sources were used for statements by the Indian, Iraqi, Libyan and Pakistani Governments about the purpose and direction of their atomic energy programs. These are the proceedings of recent sessions of the General Conferences of the International Atomic Energy Agency, and excerpts and summaries of remarks by officials appearing in the Foreign Broadcast Information Service's series of nuclear development and proliferation. The 23rd regular session, September 1980, proved to be particularly useful.

The selected statements are arranged by country. Following them is a discussion of their implications.

Selected Statements

Statements at the IAEA's 23rd General Conference, December 1979

INDIA

At the 23rd session of the General Conference of the IAEA, Mr. Singh, the delegate from India, who also delivered the inaugural address, said that India was "committed to the principles embodied in the Statute [of the IAEA] for accelerating the contribution of atomic energy to peace and prosperity throughout the world. Ever since the beginnings of its atomic energy programme over 30 years ago, India had remained steadfast in its resolve to utilize atomic energy for peaceful purposes." [78]

While suggesting India was committed to nuclear nonproliferation, the delegate chastised the IAEA for adopting discriminatory principles and procedures, and for "steering itself into a position where its overwhelming concern and the major thrust of its activities was to achieve limited nonproliferation objectives at the risk of hampering peaceful nuclear activities." [79]

Furthermore, Singh rejected the proposal to establish a nuclear-weapons-free zone in South Asia, without criticizing the principle itself.[80]

[78] International Atomic Energy Agency, 23d regular session, (GC XXIII) OR. 215, August 1980, p. 14.
[79] Ibid., p. 15.
[80] Ibid., p. 17.

LIBYA

The Libyan representative at the 23rd session, Mr. Al-Eskangi, focused his remarks on the need for nuclear power in light of the coming energy crisis. The safeguards agreement that Libya had concluded with the IAEA ". . . covered the twin objectives of using nuclear energy for peaceful purposes and strengthening the country's development plans."[81]

Al-Eskangi noted the "gap between developing and developed countries continued to grow" in nuclear technology, and urged the developed countries to increase their technical and financial assistance, in particular in connection with the fuel cycle and processing.[82] And, deploring the military nuclear activities of Israel and South Africa, he called for "the Agency to inquire into those activities and to stop all technical assistance to Israel in order to preserve the credibility of NPT."[83]

PAKISTAN

Mr. Khan, the delegate from Pakistan, stated that nuclear energy was essential, given the worsening of the energy crisis, and delimited various peaceful uses of nuclear energy in Pakistan. According to Khan, his country "had always supported the fight against proliferation. The developing countries had no intention of using the resources they so urgently needed to ensure their development for the purpose of arming themselves."[84] The delegate criticized the inefficiency of international measures to control proliferation, stressing the inability of the international community to combat proliferation and reduce stockpiles of nuclear weapons. He said:

> Those weapons continued to be manufactured and tested and the States which possessed them were not even capable of preventing other States with which they had special relationships from manufacturing them in turn. What was worse, those countries failed to denounce the actions of some countries such as South Africa when they carried out nuclear-weapon tests. The same States which were protesting against imaginary risks of proliferation and which had called for the conclusion of NPT remained silent when faced with real proliferation and appeared even to be trying to divert attention from it. Pakistan urged the Agency to work closely with the Secretary-General of the United Nations in order to clear up completely the matter of the nuclear test alleged to have been carried out by South Africa.[85]

He proposed that Pakistan and India jointly declare the region a nuclear-free-zone, which he asserted was possible because both countries had given assurances not to indulge in the manufacture of nuclear weapons, and because such a move would benefit both economically. Pakistan, he stated, hoped that the ". . . International Nuclear Fuel Cycle Evaluation (INFCE), would soon be completed and would help create conditions favorable to the development of nuclear energy."[86]

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[81] International Atomic Energy Agency, 23d regular session, (GC XXIII) OR. 216, August 1980, p. 5.
[82] Ibid., p. 4.
[83] Ibid., p. 5.
[84] International Atomic Energy Agency, 23d regular session, (GC XXIII) OR. 212, July 1980, p. 15.
[85] Ibid., pp. 14–15.
[86] Ibid., p. 16.

In this context, he called for nuclear cooperation and noted: "The fight against proliferation must not serve as a pretext for going back on existing agreements." [87]

Statements at the IAEA's 24th General Conference, September 1980

INDIA

The Indian delegate to the IAEA's General Conference, Mr. Sethna, noted that India:

> . . . had begun to take an interest in the peaceful uses of nuclear energy at a time when that field had been still very new territory, even for the developed countries. Since then, India had remained faithful to its undertaking to use nuclear energy solely for peaceful purposes and had consistently maintained that all States had the inalienable right to implement their own programmes for the purposes of economic and social development, according to their priorities and needs, since the use of nuclear energy for electricity generation was fully justified for some of the developing countries.[88]

On the Agency's activities, he deplored the focus on regulation at the expense of promotion, and reasserted the Indians view that the international nonproliferation regime was discriminatory, and that "[v]ertical and horizontal proliferation should be approached simultaneously and in the same way." [89]

IRAQ

Mr. Al-Ashimi, the delegate of Iraq stated that Iraq had ". . . adopted an ambitious economic programme based on science and technology and the peaceful uses of nuclear energy in particular." [90] The Iraqi program was "one means of resolving current energy problems." [91]

According to Al-Ashimi: "The Iraqi Government, which attached great importance to international co-operation in the peaceful uses of nuclear energy, has concluded co-operative agreements with a number of Member States [to realize that end]." [92] Iraq, he stated "had been one of the first countries to ratify the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), despite the discrimination introduced by that Treaty." [93] Moreover, "[t]he Iraqi Government had always given its full support to the Agency's activities with respect to the peaceful uses of nuclear energy and the control of proliferation." [94] In the delegate's communication of Iraq's position on a number of Agency proposals, one point is especially significant: "Activities relating to international plutonium storage and spent fuel management should not lead in the final analysis to the introduction of additional controls." [95]

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[87] Ibid.
[88] International Atomic Energy Agency, 24th regular session, GC (XXIV) OR. 220, February 1981, p. 10.
[89] Ibid., p. 12.
[90] IAEA, GC (XXIV) OR. 220, p. 5.
[91] Ibid.
[92] Ibid.
[93] Ibid., p. 6.
[94] Ibid.
[95] Ibid.

In conclusion, and in reaction to statements about Iraq's interest in obtaining a nuclear weapons capability, Al-Ashimi said:

> All countries were entitled to develop the peaceful uses of nuclear energy, without which the developing countries would not be able to catch up with the industrialized ones. The measures taken by the Iraqi Government regarding the peaceful uses of nuclear energy were under continuous attack from the Zionist regime and its supporters. The Iraqi Government was asking the Agency and all countries to denounce those attacks, to refrain from giving direct or indirect support to the campaign of vilification and to stop trying to convince it (Iraq) that it was not fulfilling its obligations with respect to NPT. Iraq, which had proved itself capable of defending its interests both inside and outside its territory, would continue its work to develop the peaceful uses of nuclear energy in accordance with the obligations it had assumed under NPT.[96]

LIBYA

Libya's delegate, Mr. Al-Eskangi, stated that Libya had fulfilled its obligations with respect to the implementation of NPT and safeguards by signing a safeguards agreement. This, he argued, "demonstrated its goodwill in seeking to realize 'atoms for peace' and to implement its programme for the development of peaceful applications of nuclear energy."[97]

According to Al-Eskangi: "The Libyan programme for the development of the peaceful uses of nuclear power was still proceeding according to plan."[98] Precisely because of this, he continued, Libya "was in urgent need of uranium and had intensified prospecting operations in the vast Libyan deserts. Since the results were encouraging, the survey work would be extended. Furthermore, as soon as the nuclear programme had moved forward, efforts would be made to develop laboratory techniques for uranium processing as a first stage in the establishment of the nuclear fuel cycle."[99]

PAKISTAN

In a communication to the Director General of the International Atomic Energy Agency dated September 13, 1980, the Pakistan Atomic Energy Commission stated:

> The national programme of Pakistan is aimed at developing nuclear energy for power generation and utilizing nuclear radiation technology for enhancing food production, improving public health and increasing industrial output. These goals have been vigorously pursued by the Pakistan Atomic Energy Commission (PAEC) during the past several years.[100]

Excerpts and Summaries of Statements From Other Sources

IRAQ

President Husayn, interview.—In an interview with Saddam Husayn by Walid Abu Zahr reported on February 7, 1980, the President of Iraq answered questions as follows:

Question. There is clamor and confusion in the Western press about what is termed "Iraq's search for producing the atomic bomb," especially after the last

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[96] Ibid., p. 7.
[97] International Atomic Energy Agency, 24th regular session, GC (XXIV) OR. 224, March 1981, p. 21.
[98] Ibid.
[99] Ibid.
[100] IAEA General Conference, 24th regular session, GC (XXIV), INF/195, Sept. 23, 1980, p. 1.

agreement with Brazil. I hope my question is not difficult when I ask: Is Iraq aiming at producing an atomic bomb?

Answer. There is no difficulty in this question. In theory, dealing with the atom, including the military uses of it, is understood all over the world. However, in practice, in order that a state may reach the capability to use the atom for military purposes, it must first reach a specific scientific and technical level, in all branches of government and not only the specific branch that deals with the atom alone.

The other matter, what interests us and preoccupies us now is to possess the experiences and the capability to deal with the atom for peaceful purposes, and in what would serve our nation, its independence and its progress. All those who foster the confusion about Iraq know that there is a great gap which Iraq has to bridge in order that it may reach the use of the atom for military purposes. They also know that Iraq's planning was not established on the basis of possessing the atom for non-peaceful purposes, but for the purpose of properly dealing with a field that serves the nation, and its goals of development and independence. But they want to deprive the [Arab] nation, by depriving Iraq, from having the technical means capable of dealing correctly and ably with the atom.

Question. This question leads us to another which is: What is your opinion on the question of introducing the atomic weapons to the area? And what is your position with regard to that?

Answer. We consider the introduction of atomic weapons into the area an extremely harmful and dangerous act. Our position in the United Nations has always been in support of global nuclear disarmament, and we have, in the United Nations, taken the position that the Middle East should be a zone free from the use of the atom for military purposes.

And on the basis of this, we are raising up in the United Nations the question of stripping the Zionist Entity of its capabilities for using the atom for military purposes. Consequently, we are against the introduction of the atom in the [Middle East] area for military purposes.[101]

President Husayn, press conference.—In a press conference in Baghdad on July 22, 1980, President Husayn said:

For years European Zionist circles have defined us as an uneducated people capable only of guiding camels. Now they are accusing us of wanting to build the atomic bomb.

Zionist propaganda forgets that we signed a non-proliferation agreement and that current research has only civilian objectives: we want to profit from modern technology only for the good of our people.

And Iraq wanted nuclear technology because oil reserves will one day be depleted. Husayn said Zionist propaganda was designed "to keep the Arabs in a state of permanent scientific underdevelopment." He castigated Israel's refusal to sign the NPT, and the military nature of its nuclear program.[102]

Iraq's Ambassador to Kuwait.—Abd al-Jabbar Umar Ghani, Iraq's ambassador to Kuwait, said on July 27, 1980:

Iraq has begun to feel that the Arab nation must develop science because by the proper utilization of science we can put an end to blackmail. Iraq, therefore, began to think of utilizing nuclear power for peaceful purposes in cooperation with friendly countries such as France.

The Israeli threats constitute a danger to Iraq. We are now witnessing disturbances in the Middle East aimed at preoccupying the Arab countries with internal problems, so that each country will be busy with its own problems and Zionism can single out Iraq. Information available to us confirms that the range of U.S. planes in Israel can reach Iraq, and we believe that the Iraq nuclear reactors are among Israeli targets, should Israel find U.S. support.

Iraq is serious about proceeding to the end of this road, and when it began this march it took the worst consequences into consideration. Zionist and U.S. threats will not dissuade us.

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[101] Al-Watan al-Arabi (Paris), No. 155, Feb. 7, 1980, p. 23. Text in Clyde Mark, Quotations regarding Iraqi nuclear intentions, CRS Memorandum, June 15, 1981, Appendix 9.
[102] LaRepubblica (Rome), July 23, 1980, p. 14. Text in Worldwide report: nuclear development and proliferation, No. 62, Sept. 18, 1980, p. 2–4.

The ambassador noted that Iraq has signed the NPT, while Israel had not.[103]

President Husayn, press conference.—On November 13, 1980, Husayn stated in a press conference:

> We will acquire atomic energy by all possible means, within the framework respecting international agreements including the nuclear non-proliferation treaty.[104]

President Husayn, to his Cabinet.—In a speech to his Cabinet on June 23, 1981, broadcast by Baghdad Radio, President Husayn said:

> Regardless of Iraq's intentions and capabilities at present and in the future, any country in the world which seeks peace and security, respects peoples and does not wish those peoples to fall under the hegemony or the oppression of external foreign forces should assist the Arabs in one way or another to obtain the nuclear bomb in order to confront Israel's existing bombs. This will realize and achieve peace regardless of the Arab's aims and capabilities.
>
> The Zionist entity and its allies are afraid of the new educational and scientific structure of the individual within a clear political framework and course that will make any Iraqi proud of his experiment and that will make him protect it and place it in service of the entire Arab nation.
>
> I do not believe that the Americans or the Soviets will now use the bomb against each other. The Americans or the Soviets and also others are always endeavoring to develop their weapons through nuclear technology for military purposes. However, this can be an open discussion with the public. This discussion is not aimed at dealing with the Arabs as those who have created a precedent, because the Arabs do not possess nuclear weapons, but with Israel because Israel does possess nuclear arms. All experts and all those concerned with atomic weapons and the Middle East admit that Israel possesses a number of nuclear bombs.
>
> What terrified Begin was our scientific, cultural, human, political, economic, social and educational development and our sound concern with knowledge, since we consider this to be one of the basic assets for building a new society and for achieving development and impregnability, whether this asset is used to ward off threats or to achieve the happiness of the individual. This made Begin spend sleepless nights.[105]

INDIA

Annual report, Indian Department of Atomic Energy, 1978–79.—The annual report of the Indian Department of Atomic Energy for 1978–79 quoted the Prime Minister as saying in July 1978: "We are wedded to the use of nuclear energy for peaceful purposes . . . and we are going on with it whatever any country might say." The report next said: "The atomic energy programme has continued to move in the light of this policy, and has been contributing to the development of the country's technological prowess." The General Survey section of the report, said in conclusion: "On the world scene, India continues to play a prominent part in promoting the use of nuclear energy for peaceful purposes."[106]

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[103] Al-Watan (Kuwait), July 27, 1980, pp. 1, 9. Text in Worldwide report: nuclear development and proliferation, No. 60, Sept. 3, 1980, p. 15.

[104] Baghdad Observer, Feb. 24, 1981, p. 2. Text in Worldwide report: nuclear development and proliferation, No. 87, Mar. 23, 1981, p. 9.

[105] Monitored and translated from the Arabic by the Foreign Broadcast Information Service. Excerpts in New York Times, June 24, 1981, p. A10.

[106] Text in Worldwide report: nuclear development and proliferation, No. 41, Apr. 30, 1980, p. 3. The Annual Report for 1980–81 is available. Interestingly, it contains no relevant statements on the general purpose or direction of Indian nuclear policy, except what can be inferred from a listing of bilateral agreements for peaceful nuclear development and references to the IAEA.

Candidate Gandhi.—On September 10, 1979, Mrs. Gandhi declared that if was returned to power, she would continue her Congress-I party's nuclear policy: "It is not our policy to make bombs, but to make whatever experiments we consider necessary in the interest of our country. It [the policy] does hold good, whatever other countries feel." [107]

Prime Minister Gandhi, in Parliament.—On March 13, 1980, Prime Minister Gandhi replying to questions in the Rajya Sabha, said that India was committed to the peaceful use of nuclear energy, but would not hesitate to undertake explosions or implosions if such were "in the national interest." She hoped that Pakistan's and China's assurances that their programs were peaceful were true, but, she said, India must make an in-depth study of programs in neighboring countries. Moreover, it was imperative that India keep ahead of the latest nuclear developments.[108]

Prime Minister Gandhi, in Parliament.—Prime Minister Gandhi stated to the Rajya Sabha, on March 27, 1980, that since uranium enrichment programs were proceeding in India and general preparation to strengthen the defense of the country was a continuing process, overreaction to the reports of Pakistan acquiring the capability to produce weapons-grade uranium was unnecessary. And, there was no reason to have a sense of insecurity.[109]

Prime Minister Gandhi, in Parliament.—Speaking before the House in July 1980, Prime Minister Gandhi reaffirmed India's commitment to the development of nuclear energy, regardless of problems in procuring fuel and heavy water, and indicated the government was planning for self-sufficiency in the nuclear field. She said the Government was not considering a peaceful nuclear explosive (PNE) at that time, but that "we shall go ahead with it if it is believed to be necessary.

After listing cooperation agreements for the peaceful use of atomic energy with 17 countries including Iraq and Libya, she said that these agreements had not yet led to the transfer of nuclear technology.[110]

Prime Minister Gandhi, letter.—In a letter to a Japanese survivor of Hiroshima, published in The Statesman on December 31, 1980, Prime Minister Gandhi wrote:

> The people and the Government of India stand for the complete elimination of nuclear weapons. On the day the bomb was dropped over Hiroshima, my father, Jawaharlal Nehru, called it the "death-dealer" and since then, we have stood for complete disarmament under effective international control. In 1976, we called for total prohibition of the use of nuclear weapons and avoidance of a nuclear war as this would amount to a violation of the U.N. charter and a crime against humanity. Our own nuclear energy programme is dedicated to the development and utilization of nuclear energy for peaceful purposes. And this was our intention in carrying out a peaceful nuclear explosion in 1974. India does not possess nuclear weapons and has no intention of developing or producing them.[111]

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[107] AFP (Hong Kong), Sept. 10, 1979. In Worldwide report: nuclear development and proliferation, No. 13, Oct. 10, 1979, p. 9.

[108] Delhi Domestic Service, Mar. 13, 1980; AFP (Hong Kong), Mar. 13, 1980. In Worldwide report: nuclear development and proliferation, No. 37, Apr. 3, 1980, p. 21.

[109] Delhi Domestic Service, Mar. 27, 1980. In Worldwide report: nuclear development and proliferation, No. 40, Apr. 25, 1980, p. 41.

[110] The Times of India, July 17, 1980, p. 5. Text in Worldwide report: nuclear development and proliferation, No. 6, Oct. 9, 1980, p. 5.

[111] Text in Worldwide report: nuclear development and proliferation, No. 82, Feb. 10, 1981, p. 35.

Director of the Bhabha Atomic Research Center.—The Director of the Bhabha Atomic Research Center, Raja Ramanna, said in February 1981: "My personal view is that PNEs (for major construction projects), will not be useful for the next 20 years. But in the next century, if one wanted to make a hole in 10 minutes or so, then there might be a case for one.[112]

Minister of State for Science Technology.—According to C. P. N. Singh, Minister of State for Science and Technology, speaking before Parliament on March 25, 1981, India would conduct a peaceful nuclear explosion if it were to believe the explosion necessary.[113]

Prime Minister Gandhi, Press Conference.—In a press conference on July 10, 1981, Prime Minister Gandhi was asked: "If Pakistan develops nuclear weapons, will India do the same?" She reportedly answered: "I do not believe in the deterrent. I do not know whether this would help." [114]

LIBYA

President Qadhafi, press report.—Early in March 1980, President Qadhafi affirmed his desire to obtain the peaceful atom, but not the military atom. He called the refusal of nations with nuclear technology to make it available to others as "reactionary" and said it "hindered world development." [115]

President Qadhafi, interview.—It was reported on January 24, 1981, that Qadhafi in a recent interview had emphasized that the Libyan Secretariat for Nuclear Energy for Peaceful Purposes was established to provide Libya with self-sufficiency in energy in the decades to come when Libyan oil reserves can be expected to be depleted.[116]

PAKISTAN

President Zia-ul-Haq statement.—Speaking in Rawalpindi on July 27, 1979, President Zia reacted to international criticism of his country's peaceful nuclear power program. External pressures had been exerted, he said, despite assurances that the objectives of Pakistan's program are "peaceful and that in view of the paucity of energy resources Pakistan has no option but to acquire nuclear technology."

Asserting that the entire nation was united behind his Government on the nuclear issue, he said: "I assure you that we shall remain steadfast in our noble resolve and will not compromise on national interest. We shall bear our vicissitudes ourselves. We shall lift our own burden. We shall eat crumbs but will not allow our national interest to be compromised in any manner whatsoever." [117]

Pakistan's Ambassador to France, interview.—In an interview published in L'Aurore on August 2, 1979, Iqbal Akhund, Pakistan's Ambassador to France, asserted the peaceful nature of Pakistan's nuclear program. Of special interest is his defense of the need for a reprocessing plant. Of this he said:

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[112] Nucleonics Week, Feb. 19, 1981, p. 14.
[113] Nucleonics Week, Apr. 2, 1981, p. 7.
[114] India News, July 20, 1981, p. 5. Different sources have reported her response differently, but India News is generally reliable.
[115] Nuclear Engineering International, April 1980, p. 7.
[116] The Arab World Weekly (Beirut), Jan. 24, 1981, pp. 3–5. Text in Worldwide report: nuclear development and proliferation, No. 84, Mar. 31, 1981, p. 36.
[117] The Pakistan Times (Lahore), July 28, 1979, p. 1. Text in Worldwide report: nuclear development and proliferation, No. 7, Aug. 29, 1979, p. 14.

Pakistan considers the contract [with France] for the construction of a reprocessing plant to be valid and it was reached after lengthy negotiations and offered the most stringent nonproliferation guarantees possible. We hope that the terms of this contract will be honored.

Everybody is aware of the rise in oil prices and of the relative shortage of this vital commodity. However, people may be less conscious of the fact that the price of uranium has risen even more sharply in recent years and that uranium reserves are also gradually being exhausted.

However, it is possible to prolong the life of uranium reserves by reprocessing the irradiated fuel from [line illegible] plutonium—an artificially produced element—which can be used as nuclear fuel. The prospects for the next 5–10 years are even more promising.

In fact a breeder reactor fed with a given quantity of plutonium produces an even greater quantity of plutonium. It has been estimated that by this process a given quantity of uranium can yield up to 80 times its initial energy value. French technology leads the world in this field, and as you know, the super-Phenix, the first commercially viable breeder reactor, will be operational in France in the near future. It is highly probable that energy savings in coming decades will be based on plutonium.[118]

President Zia-ul-Haq, news report.—On October 28, 1979, TASS reported President Zia said that he reserved the right to decide to detonate a nuclear explosive device if this was required for the further development of Pakistan's atomic power energetics.[119]

President Zia-ul-Haq, interview.—In an interview reported in the Frankfurter Rundschau on February 29, 1980, President Zia spoke as follows about the intentions of Pakistan's nuclear program:

Our nuclear energy exclusively serves peaceful purposes. We do not develop any bomb, we are not for nuclear weapons, the history of my government—the past 2 years—is an open book.

We have suggested that the Indian Ocean, the entire region, be declared a denuclearized zone, and we have stated that the havenots must be granted guarantees by the countries having nuclear weapons. After all, this whole thing is a policy of peaceful utilization.

As for former Prime Minister Bhutto's statement of the need for a Muslim, or Islamic, bomb, President Zia deemed it politically motivated and ultimately irresponsible.[120]

Pakistan's Interior Minister for Religious Affairs.—According to the Interior Minister for Religious Affairs, Mahmud Haroon, Pakistan had "no intention" of developing nuclear weapons. The Pakistani nuclear program was "exclusively for peaceful purposes. We have no intention of following the example of India, Israel or South Africa in this regard." [121]

A foreign office spokesman.—In reaction to an official Indian statement that Pakistan desired to acquire a nuclear weapons capability, and that deplored the effects of such a move on regional tensions, a spokesman for Pakistan's foreign office in September 1980 reasserted Pakistan's sole commitment to the peaceful utilization of nuclear technology. He said that Pakistan's good intentions and assurances could not be doubted because of its proposals to establish a nuclear weapons free zone, to have India and Pakistan accept full scope safeguards and

[118] Text in Worldwide report: nuclear development and proliferation, No. 6, Aug. 23, 1979, pp. 13–15.

[119] TASS (Moscow), Oct. 28, 1979. In Worldwide report: nuclear development and proliferation, No. 20, Dec. 3, 1979, p. 15.

[120] Text in Worldwide report: nuclear development and proliferation, No. 36, Mar. 28, 1980, p. 34–35.

[121] AFP (Hong Kong), June 24,1980. In Worldwide report: nuclear development and proliferation, No. 55, Aug. 8, 1980, p. 22.

sign the Non-Proliferation Treaty, and to have India, Pakistan and others renounce the manufacture of nuclear weapons. Furthermore, Pakistan itself was worried about India's statement that it reserved the right to carry out more nuclear tests.[122]

Chairman, Pakistan's Atomic Energy Commission.—Dr. Munir Ahmad Khan, Chairman of PAEC, speaking at a seminar in Lahore in October 1980, explained the necessity of expanding Pakistan's nuclear power program and of acquiring a nuclear reprocessing plant. Despite "unacceptable Western propaganda" opposing Pakistan's acquisition of recycling technology, Pakistan was committed to the peaceful development of nuclear energy, for it understood the dangers of nuclear proliferation.[123]

President Zia-ul-Haq, news report.—In January 1981, President Zia reportedly emphasized the peaceful intent of the Pakistan's nuclear power program, saying the entire program was to fulfill Pakistan's energy needs, and there was no reason to deprive Pakistan of the nuclear technology for being a Muslim, a developing, and a non-aligned country.[124]

Pakistan's representative to the United Nations.—Denying rumors that Pakistan was developing an Islamic bomb, and had received money from Libya for that purpose. Shamshad Ahmad, Pakistan's acting permanent representative to the United Nations, stated on February 11, 1981:

> The nuclear research and development programme of Pakistan is geared entirely to peaceful purposes. Pakistan has not sought or obtained financial assistance from the Libyan Jamahiriya or from any other source in this respect.
>
> The nomenclature of an "Islamic bomb" makes it quite evident that the Zionist circles have planted such stories in the information media in an effort to malign Islamic, non-aligned and third-world countries.
>
> The bogey of the so-called "Islamic bomb" is part of Israel's overall strategy of hiding its own real intentions of acquiring nuclear weapons.[125]

Chairman, Pakistan's Atomic Energy Commission.—Defending Pakistan's position with respect to nuclear energy in a committee of the IAEA, Munir Ahmad Khan said that for Pakistan:

> The single most important issue in the world today was energy supply as it touches on the security, economic development and the survival of many nations.[126]

Pakistan's Foreign Minister, interview.—In an interview with N. Ram published in the Hindu, on May 2, 1981, Agha Shahi, Pakistan's Foreign Minister, gave the following answers to questions about nuclear weapons and proliferation:

> *Question.* May I get your thoughts on the issue of nuclear non-proliferation? You have already mentioned the U.S. response, which you considered unwarranted, to your reprocessing arrangement with France in an earlier period. Now, there seems to be common elements in India's and Pakistan's positions. They are rather well known. But there is also talk about developing a nuclear strategic capability—on both sides of the course . . .

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[122] Karachi Domestic Service, Aug. 3, 1980, p. 26. In Worldwide report: nuclear development and proliferation, No. 61, Sept. 10, 1980, p. 26.

[123] AFP (Hong Kong), Oct. 18, 1980. In Worldwide report: nuclear development and proliferation, No. 69, Nov. 7, 1980, p. 23.

[124] Morning News (Karachi), Mar. 30, 1981, p. 4. Text in Worldwide report: nuclear development and proliferation, No. 91, Apr. 15, 1981, p. 9.

[125] The Working People's Daily (Rangoon), Feb. 13, 1981, p. 7. Text in Worldwide report: nuclear development and proliferation, No. 86, Mar. 13, 1981, p. 15.

[126] Morning News, (Karachi), Mar. 30, 1981, p. 4. Text in Worldwide report: nuclear development and proliferation, No. 91, Apr. 15, 1981, pp. 9–10.

Answer. On your side. Because you're turning to rocketry. You're close to the Soviet Union. You've already put something into orbit. We haven't even started . . .

Question. Let me ask you this question, Mr. Shahi, if you would care to respond to it directly. You mentioned that reprocessing . . . When you enter into that arrangement, there is no problem. Now Pakistan has no way of using enrichment, enriched uranium in the near future . . .

Answer. Excuse me, we have. We're going to go in for a power water reactor. And all the uranium we can enrich will be barely sufficient for that reactor. Six to eight hundred million dollars . . . We delayed this because we had some difficulty in raising finances . . . You know the cost of nuclear power stations has been going up. We have plans for a nuclear power reactor based on enriched uranium. This is what we are going to do.

The United States says, your programme is a threat, you open it for inspection. We say, don't be discriminating. They say, give us an assurance. We have given them an assurance that we are not engaged in the manufacture of nuclear weapons, that we are not conceiving aid for this programme from any source. And I even told them that the question of a peaceful nuclear explosion is also not a foregone conclusion. When and if we attain the capability, we will take into account all the various factors. Let us wait and see what the Committee on Disarmament does on peaceful nuclear explosions.

I'm told that the three nuclear powers—the Soviet Union, the U.S. and the U.K.—have drafted a protocol on these nuclear explosions. And the other countries—Argentina, Brazil and others—said: Why should only the nuclear weapons powers have the privilege of carrying out nuclear explosions? So we may have a regime for peaceful nuclear explosions and that is something in the future.

But we do not have a nuclear weapons programme. I challenged Mr. Vance (Mr. Cyrus Vance, former U.S. Secretary of State) and I challenge anybody today: produce any evidence. It's not enough to say you're engaged in this, you're suspected of this. You have so much intelligence capability. Produce some evidence—before us and the world—that we are engaged in manufacturing nuclear weapons. But if you charge us and accuse us and say we've got money from Col. Qadhafi . . . it is totally false. I said, all right, if we got this money produce some evidence.

So, you know, they are making these accusations and I'm sorry to say that in India it is assumed we are engaged in manufacturing nuclear weapons. And, therefore, India must do it.

We're worried now that you're going to carry out some tests. If we don't say anything, it is again not to enter into a controversy. But what have you to fear?

And I can tell you categorically we're not engaged in the manufacture of nuclear weapons. About nuclear explosions, we shall see if and when we get the capability. We will find out what international regime is envisaged. And we have told you we're ready to talk to you . . . to exchange mutual assurances. If you want, let us agree to reciprocal inspection—if you don't agree to international agreement. And I say, all right, even without inspection let us engage in a binding declaration not to manufacture nuclear weapons. What more can we do? Short of saying, "you come and inspect us and you will not let us inspect your facilities" . . .

Question. Nobody would make that demand, or take that unreasonable position?

Answer. Short of that what more you want us to do, we're ready to do.[127]

Analysis and Discussion

OVERVIEW

General remarks

The preceding set of statements and summaries reveals an overarching theme advanced by these countries: that the civilian nuclear programs of India, Iraq, Libya and Pakistan all are peaceful in nature and intent, and will not be misused to produce nuclear weapons. Their statements for international consumption underscore this reassuring theme. However, their statements for domestic consumption are some-

[127] Hindu, May 2, 1981, p. 8.

times less specific and may even hint strongly at an intention to seek such weapons under certain conditions. The ambiguity of the latter statements contributes to uncertainty in the application of U.S. nonproliferation policy to these countries. Prudence suggests that suspected intention be judged in light of both nuclear capability and of conventional and nuclear defense options. Whether or not these countries can make nuclear weapons now or in the near future, and the extent to which acquisition and possession of nuclear weapons could affect their security and national self-interest, would appear to be cardinal concerns of a prudent U.S. policy. With this in mind, the implications of statements by these four countries before the International Atomic Energy Agency and in other, primarily domestic settings will now be discussed.

Reasonable implications of statements before the IAEA

Statements by official delegates of India, Iran, Libya and Pakistan before two recent General Conferences at the IAEA show fundamental similarities in their assurances of a commitment to the peaceful use of nuclear power. However, one would scarcely expect otherwise in an international forum devoted to peaceful atomic energy. To conform to international standards of acceptability, however, leaves unanswered the question of how much influence such statements might have on a hidden commitment to nuclear weapons, or how much weight world opinion might carry in a national decision on nuclear weapons. To date, the pressure to conform may be one reason these countries have not resorted to an open break with a major purpose of the Agency, which is to reduce or constrain the link between nuclear power and nuclear weapons. Still, such reassuring official statements may conceal hidden motives, and are sometimes ambiguous concerning activities short of actual weapons development and production. On the other hand, these public reassurances would probably make it difficult for the United States to mobilize world opinion against a suspected nation until it has taken some overt action that unmistakably signals an intent to acquire nuclear weapons.

Reasonable implications of other public statements

Statements made by high officials, politicians and nuclear scientists, in other situations, particularly before parliaments and other domestic audiences, frequently included a deferential nod toward the generally accepted world commandment: "Thou shalt not acquire nuclear weapons." These pronouncements, however, would often have this commandment apply to others, but perhaps not to themselves, thereby implying the proposition that there are "good" bombs and "bad" bombs, with the difference depending upon who has them and for what purposes.

The frequent sounds of nuclear saber rattling are as much to be expected as are the reassurances mentioned in statements before the IAEA. The context of such statements requires consideration. Statements to a restive parliament may include bravado to neutralize domestic critics. Governmental statements aimed at unfriendly or hostile neighbors likewise may be designed to deter that neighbor from certain actions through the implicit threat of nuclear retribution. Likewise official statements which at their face value may imply a threat

to acquire nuclear weapons must be weighed against capabilities to do so.

THEMATIC ANALYSIS OF STATEMENTS

Statements before the IAEA

At the general conferences of the International Atomic Energy Agency, official delegates of Iraq and Libya, as well as India and Pakistan, expressed their commitment to peaceful uses of atomic energy. Indeed, Iraq explicitly denied reports that it sought an atomic weapons capability. All of these countries, furthermore, defended their peaceful nuclear programs by citing the imperatives of developing nuclear power; by announcing their opposition to spread of nuclear weapons; and by arguing that the primary goal of the IAEA is promotional, not regulatory.

Nuclear energy and economic and social development.—India, Iraq, Libya, and Pakistan have all stated that nuclear power is necessary for them because of the imperatives of economic and social development. For them, a greater utilization of this alternative is demanded by the impending global energy crisis, which they say will be especially destructive in developing countries. Even Libya and Iraq, which are oil rich members of OPEC, say they are compelled to develop nuclear energy because their oil reserves eventually will be depleted. Not insignificant in the arguments of these countries are the benefits seen in applications of nuclear knowledge to such fields as agriculture and medicine.

Stopping the further spread of nuclear weapons.—The repeated statements of commitment to peaceful use of nuclear power can be read as a pledge by these countries not to acquire nuclear weapons, but not as a guarantee against so-called "peaceful nuclear explosions." Further, they do not imply support of the NPT, or agreement with U.S. non-proliferation policies and measures.

Each of these four States went on the record in opposition to nuclear proliferation in principle. Pakistan, Libya, and Iraq have criticized, implicitly or explicitly, the acquisition of nuclear weapons by States such as Israel and South Africa, but have not always called for blanket prohibition. Libya and Iraq are signatories of the NPT. But India and Pakistan have not signed the NPT and do not support it.

Promotional and regulatory functions of IAEA.—For these four countries, a commitment to the peaceful atom does not mean that they agree to a strong non-proliferation role for the IAEA. Rather their statements indicate they see the Agency's primary function to be technical assistance and promotional, whereas the United States and other nuclear supplier nations believe the principal function should be regulation. If they discuss the question of discrimination in this forum, they believe the international nuclear regime under the IAEA to be unduely responsive to the major powers and so to be discriminatory. India is particularly adamant on this point.

Public statements in other forums

The official pronouncements of these four countries at the General Conference of the IAEA are reflected in the public statements in other

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places of officials, whether statesmen or scientists. These public statements differ in one respect, however, from those before the IAEA. They were uttered in a different political context, and that context can influence what is said, particularly in statements for domestic consumption in Parliaments.

Iraq.—Statements of Iraqi officials appear intended to counter hostile international reactions to the alleged military thrust of its nuclear program, specifically the attempts to acquire from France and Italy technology and equipment to produce plutonium. Denials of its intention to obtain nuclear weapons are paramount, with frequent references to the country's NPT member status. Since Iraqi interest in nuclear weaponry is seen as a response to suspicions that Israel has such weapons, those denials are often couched in abusive anti-Israeli language.

Pakistan.—In Pakistan, too, the statements of officials appear to be primarily a reaction to international criticism of Pakistan's attempts to acquire its own capacity to produce plutonium and enriched uranium, and to alleged preparation of a nuclear test site. While the regime of President Zia has denied Pakistan's intention to detonate an explosive, its right to do so has been asserted.

India.—Indian officials, quite differently, appear to anticipate the prospects of a Pakistani bomb. So while they reiterate the peaceful intent of their nuclear program, Prime Minister Gandhi and others have held open a nuclear weapons option, usually linking it to Pakistan's behavior. The statement on deterrence attributed to Prime Minister Gandhi in her July 10 press conference seems to suggest, however, that an Indian nuclear countermove to a Pakistani nuclear explosion would perhaps not be useful and might not be undertaken. As for nuclear power, India has justified its peaceful development on the grounds of economy and independence.

Libya.—The statements from Libya are mainly from President Qadhafi himself. In them he does not reply to charges that Libya is pursuing nuclear weapons and financing an "Islamic Bomb." Instead, he has given assurances that the prospective Libyan nuclear power program is for peaceful uses.

ISSUE 3: THE POTENTIAL FOR ATTAINING NUCLEAR WEAPONS CAPABILITY POSSESSED BY INDIA, IRAQ, LIBYA AND PAKISTAN

An analysis of the potential of India, Iraq, Libya and Pakistan for attaining a nuclear weapons capability first needs to consider what is a nuclear weapons capability; then how close to it now are these four countries; and, finally, how close might they come within this decade.

Nuclear Weapons Capability Defined

For the late 1960's and well into the 1970's, the nuclear weapons capability of a state was equated with its manufacture of such weapons or its acquisition of them from other states.[128] So the distinction between a nuclear weapons state and non-weapons state was simple. A state either had bombs or it did not.

By the mid-1970's, particularly after the Indian nuclear explosion of May 1974 and the warnings of writers such as Theodore Taylor, Mason Willrich and Albert Wohlstetter, the U.S. working definition of weapons capability began to expand to include possession of nuclear materials, most notably highly enriched uranium and, or, weapons grade plutonium, which could be diverted from nuclear power uses to make nuclear weapons and explosives. In the Nuclear Non-Proliferation Act of 1978, Congress clearly expressed this broadened definition in its statement that:

> The Congress finds and declares that the proliferation of nuclear explosive devices or of the direct capability to manufacture or otherwise acquire such devices poses a grave threat to the security interests of the United States and to continued international progress toward world peace and development.[129]

Congress further underscored the linkage between certain nuclear materials and facilities and the spread of nuclear weapons in its direction to the President to seek agreement from all nations and groups of nations to adhere to common nuclear export policies. Section 403(b)(1) of the Act sets out the following as the goal for such negotiations:

> No source of special nuclear material within the territory of any nation or group of nations, under its jurisdiction, or under its control anywhere will be enriched . . . or reprocessed, no irradiated fuel elements containing such mate-

[128] The pledge of non-nuclear weapons states party to the Non-Proliferation Treaty in article II is ". . . not to receive from any transferor whatsoever of nuclear or other nuclear explosives or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices."

[129] The Nuclear Non-Proliferation Act of 1978, section 2.

rial which are to be removed from a reactor will be altered in form or content, and no fabrication or stockpiling involving plutonium, uranium 233, or uranium enriched to greater than 20 percent in the isotope 235 shall be performed except in a facility under effective international auspices and inspection, and any such irradiated fuel elements shall be transferred to such a facility as soon as practicable after removal from a reactor consistent with safety requirements. Such facilities shall be limited in number to the greatest extent feasible and shall be carefully sited and managed so as to minimize the proliferation and environmental risks associated with such facilities. In addition, there shall be conditions to limit the access of non-nuclear weapon states other than the host country to sensitive nuclear technology associated with such facilities.

(2) Any facilities within the territory of any nation or group of nations, under its jurisdiction, or under its control anywhere for the necessary short-term storage of fuel elements containing plutonium, uranium 233, or uranium enriched to greater than 20 percent in the isotope 235 prior to placement in a reactor or of irradiated fuel elements prior to transfer as required in subparagraph (1) shall be placed under effective international auspices and inspection.

This Congressional statement clearly reflects the view that a state producing and using highly enriched uranium or plutonium as nuclear fuels is much closer to nuclear explosives or weapons than is a state that uses low enriched uranium or perhaps natural uranium with no subsequent reprocessing, and that buys uranium enrichment services abroad.

Nuclear Devices, Explosives, Weapons, and Arsenals

The terms "nuclear device," "nuclear explosive" and "nuclear weapons" often are used interchangeably. There are, however, some distinctions to be kept in mind.

A nuclear device can be thought of as an assembly of parts and equipment which could be set up somewhere, presumably at a test site, as a proof of principle experiment. It need not be reliably transportable or, until tested, predictable in performance. It could be used for political purposes to signal that the testing state had joined at the least outer circle of the weapons states. A nuclear explosive would be the next step, something portable, although probably still requiring time to set up and prepare, exemplified by the "peaceful nuclear explosives" developed by the United States and the Soviet Union. A nuclear weapon implies further refinement in design and manufacture to produce a reliable, predictable bomb capable of being carried by missiles, aircraft or other means, one that a head of state or a military commander would be willing to rely upon to perform as advertised. In terms of U.S. experience, the test at Alamogordo in July 1945 was a nuclear explosive. The bombs dropped on Hiroshima and Nagasaki a few weeks later were crude weapons.

The reason for this distinction is that although a test of a nuclear device can demonstrate a state can cause an explosive release of nuclear energy, it does not in itself indicate the future intentions of the state, whether it will seek a nuclear arsenal, and, if so, how long it would take. Several tests, on the other hand, would be a more persuasive indication of a state's interest in building a nuclear arsenal and its ability to do so. One test does not an arsenal make. It would, however give strong reason for the United States and other states to do something to prevent the next step.

Nuclear Weapons Capability, Its Substance

The expanded definition of nuclear weapons capability implies that the possession of the following brings a non-nuclear weapons state closer to weapons status: uranium resources, enrichment capacity and inventories of highly enriched uranium; plutonium production capacity in the form of large research reactors, and power reactors capable of producing weapons grade material; power reactors capable of producing commercial grade plutonium; reprocessing capacity and inventories of weapons grade plutonium; [130] and heavy water production capacity.[131]

To translate this wherewithal into nuclear explosives or weapons requires development, design, engineering and manufacture of the device itself. While much basic information about principles of nuclear weapons and explosives has been published, there remains a substantial body of technology and experience that would have to be obtained either by replicating what the United States and other nuclear weapons states have done in their own laboratories, or by obtaining assistance from some other state, or perhaps by acquiring the services of someone already proficient in bomb design and manufacture. A simplifying assumption of this analysis is that a state opting to divert nuclear materials from nuclear power or to make them in clandestine facilities would have brought its weapons design and manufacture far enough along so that after diversion or production, all it would have to do would be to fabricate the nuclear material into previously designed shapes and put it into the device. To have a weapon design and manufacture incomplete at the time of a diversion would increase the risk of detection and counteraction by other nations before a nuclear explosive or weapon could be made ready for use.

The Potential for Attaining a Nuclear Weapons Capability

The potential for a state to attain a nuclear weapons capability depends upon its access to weapons grade enriched uranium or plutonium; how much it wants nuclear weapons, and what risks it is willing to incur to get them; what pressures push it toward nuclear weapons and what forces may restrain it; the capacity of its industrial and technological base; and its wealth.

Fear of enemy states, a desire to dominate and influence its neighbors or reaction to suspicious nuclear activities of a neighboring state, can lead a government to opt for nuclear weapons. Likewise, an unfavorable world attitude toward nuclear weapons; fear of early discovery by inspection, intelligence or otherwise; and fear of possible

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[130] It has been fashionable to infer that commercial grade plutonium produced by long exposure in a nuclear power reactor, which is typical of plutonium in spent fuel from light water reactors, can be readily used with little prior experience to make a reliable, predictable nuclear explosive as is admittedly the case for plutonium produced by shorter exposure, as in some designs of heavy water power reactors or large research reactors. The United States apparently argued without challenge the utility of commercial grade plutonium for weapons during the International Nuclear Fuel Cycle Evaluation. The Summary INFCE report included the following statement: "The U.S. Government had declared that commercial grade plutonium can be used for weapons purposes and this statement was not challenged by other nuclear weapons states."

[131] Power reactors using natural uranium for fuel and moderated with heavy water, as in the Canadian design, usually are thought of as producers of high quality plutonium.

world reactions and sanctions or hostile reaction from a super power could be restraints.

Since factors affecting the desire and will of a state to acquire nuclear weapons can vary among states, and also with the times and circumstances, this analysis goes no further than to note the existence of these factors. Suffice to say that a state with few nuclear resources is unlikely to be taken seriously as able to produce nuclear weapons, no matter how intense may be its motivation. On the other hand, states more generously endowed with resources and industry would be considered more able to take the final step to weapons status if they chose to. A wealthy state with a well developed body of scientists, engineers and technicians active in nuclear science and technology, together with capacities in manufacture of chemicals and electronics, in metallurgy and in mechanical engineering could be expected to develop a nuclear weapons capacity sooner and more predictably than a poorer state lacking these assets. This comes as no surprise for it can be said also of other modern technologies.

The following analysis for India, Iraq, Libya and Pakistan is focused on the ability, rather than the will or intentions, of these states to make nuclear weapons. For this purpose, the principal factors considered to indicate the potential for attaining a nuclear weapons capability also include the intellectual base in the form of scientists, engineers and technologists and the industrial base of a state.

India's Potential for Attaining a Nuclear Weapons Capability

By its nuclear explosion of May 1974, India already has demonstrated that it can design and make a nuclear explosive compact enough to fit into the drill hole for an underground test, which suggests a compactness and configuration close to that for a usable nuclear weapon. India continues to produce plutonium, not all of which is under IAEA safeguards. The unsafeguarded plutonium in principle could be used to make more explosives or weapons without violating safeguards agreements for the material subject to inspection. During the 1980's it seems prudent to expect India may try to use plutonium to fuel its experimental breeder reactor and perhaps its Tarapur Atomic Power Station if the United States does not resume delivery of nuclear fuel for the latter. Certainly India's supply of unsafeguarded plutonium can be expected to increase as their domestically produced nuclear power reactors come into operation and their spent fuel becomes available for reprocessing. On the whole, India entered the 1980's with a demonstrated capacity to make a nuclear explosive and probably will enter the 1990's with a capacity to produce an arsenal of nuclear weapons if it chooses to.

India's current potential.—India has a solid intellectual base in the scientists and engineers educated in its universities and nuclear research centers, as well as abroad. It has some uranium which frees it from conditions attached by some supplier countries. Because it chose the natural uranium, heavy water type nuclear power reactor, it is also free from conditions required by some foreign suppliers for uranium enrichment. India's large resources of thorium, although not contributing to its present nuclear weapons capability, ultimately

could be used to produce uranium-233 as a nuclear fuel material. Unfortunately, U–233 also is deemed to be weapons material.[132]

India already can produce some plutonium and recover it from spent fuel (reprocessing). It hopes to be able to produce enough heavy water for its nuclear powerplants under construction, although production is still short. On the other hand, much of the unrecovered plutonium now in India is in the spent fuel of the Tarapur Atomic Power Station and is of commercial rather than weapons grade. With India's expected growing access to higher quality plutonium from its unsafeguarded heavy water type nuclear power reactors, it would seem unlikely that plutonium from Tarapur would wind up in nuclear explosives, although it might be used to free higher quality plutonium from other uses for this purpose.

India's future potential.—During the 1980's it is prudent to expect India to complete its five nuclear power reactors now under construction and perhaps start construction of more, to complete its experimental breeder reactor and bring it into operation, to use some plutonium for fuel in its breeder experiment and perhaps for the Tarapur Atomic Power Station, to further expand its heavy water production and its fuel reprocessing capacity, and to make progress towards production and use of U–233 as a nuclear fuel. Should India's nuclear power efforts succeed, India itself might become a supplier of this type plant and heavy water to other developing countries. It seems unlikely that India would change from natural uranium to low enriched uranium for its nuclear power because it lacks enrichment capacity and shows little interest in acquiring one.

Taken together, all of this puts India in a position to quickly resume testing of nuclear explosives and weapons, and to bring it close to the production of an arsenal of nuclear weapons by the 1990's.

Iraq's Potential for Attaining a Nuclear Weapons Capability

For some time there has been speculation that Iraq has intended to get close to a nuclear weapons capability while continuing to profess a disinterest in making them. At the time of writing, Iraq's long term potential had been reduced by Israel's bombing of Iraq's large research reactor. The assistance which that reactor might have provided now will not be available until it is rebuilt. As for the future, if the reactor is rebuilt by the 1990's Iraq at best might be able to produce enough plutonium for a few nuclear explosives, but would lack a capability to produce an arsenal of nuclear weapons. Any introduction of large scale foreign nuclear technical assistance and supply could, of course, markedly change this assessment.

Iraq's current potential.—Whatever potential Iraq had to attain a nuclear weapons capability was substantially reduced by Israel's destruction of Iraq's large nuclear research reactor on June 7, 1981. Without this reactor as the core for its nuclear research center, Iraq has little to attract scientists and engineers from other Arab countries for study and research there, which would have benefited the cadre of professional and technical personnel that Iraq is trying to

[132] While in theory, U–233 is suitable for weapons, its strong emission of gamma radiation would complicate weapons design and pose risks of dangerous radiation exposure to those working with this material.

develop. Without the reactor, Iraq has no consequential source of plutonium for experimental work to gain first hand experience with properties of this nuclear material. Iraq does have in its possession some unused fuel for the damaged reactor, which contains 93 percent enriched uranium. Depending upon the amount on hand and assumptions about how much of this material would be needed for a nuclear explosive, Iraq might have enough for one device, but probably not enough for the experimental and development work needed to design, engineer and make the first such device.

Iraq's industrial base has little, if any, capability in technologies associated with weapons production, such as electronics, mechanical engineering, chemical engineering, metallurgy, and nuclear engineering. While Iraq apparently has been able to buy uranium concentrates from other suppliers, it appears not to be producing uranium itself.

So, at the time of writing, Iraq's potential for attaining nuclear weapons capability within a few years, which was not high to begin with, had faded markedly.

Iraq's future potential.—By 1990, Iraq could have more nuclear scientists, engineers and technicians, but no domestic source of highly enriched uranium; a possible source of a few kilograms of plutonium annually, if the reactor is rebuilt, but no nuclear power. What might be Iraq's potential for attaining a nuclear weapons capability by 1990 will depend upon many imponderables, including the priority Iraq may choose to devote to repair the damage done by Israel and to revive its nuclear research center as a showplace for Arab nuclear study and research. Saudi Arabia, as indicated, has offered to finance reconstruction. It will depend also upon the willingness of other states to provide Iraq with supplies, equipment and technical assistance, for it appears unlikely that Iraq could become independent of foreign help by 1990.

Assuming that the research reactor were to be rebuilt and put into operation by the late 1980's, it seems unlikely that Iraq's intellectual and industrial base can grow enough to materially reduce its dependence upon foreign imports and technical assistance during this time. It seems unlikely too that Iraq's own industries will be able to design and build a reprocessing plant, an enrichment plant, or a nuclear power station for many years to come. If the reactor is rebuilt, by the turn of the decade Iraq could have somewhat more scientists and engineers with personal experience with nuclear physics, nuclear reactions, and the handling of plutonium and radioactive material in laboratory quantities. If the reactor could be run solely as a plutonium producer, enough plutonium might be produced for several explosives a year, depending upon assumptions for the minimum amount needed for the kind of device Iraqian engineers might design, and prospects for detection of this work and counteraction by other countries.

If Iraq could get a supply of reactor grade graphite and some uranium, and if it could get some experienced engineers and technicians, it might be able to build a small plutonium producing reactor and a small reprocessing plant that together might annually produce enough high quality plutonium for one or two explosives. This assumes the undertaking could be kept secret for several years so that other countries would not have an opportunity to take countermeasures. While the success of such an undertaking cannot be ruled out as impossible, it nonetheless appears to be improbable.

In summary, Iraq's potential nuclear weapons capability at the outset of the 1990's would still be small, assuming that it does not get access to engineers and technicians experienced in the production of nuclear weapons materials.

Libya's Potential for Attaining a Nuclear Weapons Capability

For some time there also has been speculation about Libya's intentions to get close to a nuclear weapons capability. At the time of writing, Libya has little potential to attain nuclear weapons through its own efforts. As for the future, while it could come somewhat closer to a nuclear weapons capability by 1990, even then it would still have far to go unless it were able to obtain extensive technical assistance and supplies from abroad. It probably would not have enough weapons grade material to conduct a test and certainly would be far from any capability to produce enough for a nuclear arsenal.

Libya's current potential.—In terms of personnel, inventories of nuclear weapons materials, and facilities to produce them, Libya has little current potential to attain nuclear weapons through its own efforts. It appears to have little intellectual base of scientists, engineers and technicians experienced in the production of nuclear materials and the operation of nuclear reactors and other facilities. It has no reactors in operation, only one research reactor under construction, and, so far, only inconclusive talks with the Soviet Union about the supply of a nuclear powerplant. Libya may be able to find and produce uranium in Chad, but apparently has not yet done so. It has no facilities to reprocess spent fuel or to enrich uranium. Finally, it is heavily dependent upon external sources for equipment and technical assistance.

Libya's future potential.—By 1990 Libya could somewhat increase its supply of nuclear scientists, engineers and technicians, although most likely with extensive foreign assistance. It might also find a supply of uranium in Chad. Libya could have a small research reactor in operation and possibly a nuclear powerplant if the Soviet Union moves quickly to supply it. The spent fuel from such a plant could be a potential source of low quality plutonium if the Soviet Union does not require its return after use. However, it seems unlikely that Libya by then could have a working reprocessing plant for this kind of spent fuel, or an enrichment capability, or the industrial base to build either without extensive external assistance.

If Libya could get a supply of reactor grade graphite uranium, and some commonplace industrial equipment, and if also it could get some experienced engineers, it might be able to build a small plutonium producing reactor and a small reprocessing plant to produce enough plutonium annually for several explosives. This assumes such an undertaking could be kept secret so that other countries would not have opportunity for countermeasures. While this cannot be ruled out as impossible, it nonetheless appears to be improbable.

In summary, Libya's potential nuclear weapons capability at the outset of the 1990s would still be quite small, assuming that it does not get access to engineers and technicians experienced in production of nuclear weapons materials.

Pakistan's Potential for Attaining a Nuclear Weapons Capability

At the moment it is not clear whether Pakistan can produce nuclear weapons materials. It is trying to build both a reprocessing plant and an enrichment plant, but their precise status cannot be judged from the literature. Since Pakistan needs neither for its present single nuclear powerplant, these efforts are regarded with suspicion. For the future, by the 1990's Pakistan might be able to produce as much as 50 kilograms of plutonium a year, although of uncertain quality for weapons use. Such production would be enough to test some nuclear devices and to start a nuclear arsenal.

Whether Pakistan by 1990 could also have a source of highly enriched uranium is less certain, for its current effort could fail. However, prudent planning probably would assume that Pakistan can succeed and would be able to produce weapons grade uranium.

By 1990, if things go well, Pakistan could have a large light water nuclear power plant about ready for operation, and perhaps another in construction. If Pakistan does not have to return the spent fuel from these reactors to the supplying state, this spent fuel in theory could be reprocessed to produce its reactor grade plutonium. It seems unlikely that Pakistan's present reprocessing efforts if successful would be able to reprocess commercial fuel. Even if Pakistan could, it seems unlikely that inexperienced weapons designers could successfully use commercial grade plutonium to produce reliable, and predictable nuclear weapons. So acquisition of large LWR power reactors could do little directly to increase Pakistan's nuclear potential. Indirectly, they could provide training and experience for Pakistani engineers which would be useful for nuclear materials production.

In summary, Pakistan's potential nuclear weapons capability by 1990 would be enough to produce some nuclear explosives, using plutonium or highly enriched uranium. This increase in nuclear weapons potential would be greater if it has access to engineers and technicians experienced in the production of nuclear weapons materials.

Pakistan's current potential.—Observation of Pakistan's nuclear activities indicate that it is trying hard to create its own supplies of weapons grade nuclear materials. It is training many nuclear scientists and engineers, although how many are being trained in the technologies for producing nuclear material is not clear. Training programs could help Pakistan should it seek nuclear leadership among the Islamic states. Pakistan apparently is producing some uranium and perhaps some heavy water. Its one nuclear powerplant in theory might produce as much as 55 kilogram of plutonium a year, although in normal power operation this plutonium probably would have more Pu–240 than is desirable for weapons use. Again, in theory, by running more uranium through this reactor to generate the same electricity, the quality of the plutonium would be improved, but the increased uranium flow could be detectable. As for recovery of plutonium from spent fuel, while Pakistan is trying to complete two reprocessing plants, it apparently has yet to do so and the literature does not indicate when these may be completed.

Pakistan also is trying to build a uranium enrichment plant using gas centrifuge technology allegedly stolen in part from Urenco, and

by covertly importing parts and equipment for this plant, most notably equipment to produce uranium hexafluoride and electrical inverters with technical characteristics that match those needed for the centrifuge drive mechanisms. Pakistan's industrial base would appear to be of little help other than providing the materials for the buildings required.

A critical question is how soon Pakistan might start producing separated plutonium or highly enriched uranium. The available information is ambiguous. Some suggests Pakistan already has enough plutonium for a test explosion this year, although other information would indicate this is unlikely. Prudence suggests an intelligence effort to find out.

Pakistan's future potential.—By the end of the 1980's it seems likely that Pakistan will have expanded its intellectual base of nuclear scientists, engineers and technicians, and may be producing some uranium and heavy water. By then the success of its reprocessing and enrichment efforts should be clear. Assuming no outside action to stop Pakistan, it probably could have some reprocessing capability by 1990. As for enrichment, since this technology is more demanding, it cannot be concluded that Pakistan's efforts will be successful, or that if the enrichment plant is brought into operation it would be able to produce highly enriched uranium. Much would depend upon the kinds of technical problems Pakistan's engineers would encounter and how much help, if any, they might get from other countries.

Concerning nuclear power, by 1990 Pakistan is likely to still have the KANUPP reactor in operation, assuming it can make or import replacement parts. If Pakistan's ambitious nuclear power plan succeeds, it could have one large (600–900 MWe) nuclear powerplant near completion and perhaps another in construction. If light water reactors are used, they would need low enriched uranium which Pakistan probably would have to import. The spent fuel from such reactors typically could contain as much as 260 to 385 kilograms of Pu–239 per year depending upon the size of the power reactor. While Pakistan's reprocessing plant at Chasma if completed might be able to reprocess LWR spent fuel, it is unlikely that the smaller plant at Pinstech could do so, although it probably could handle the spent fuel from the KANUPP reactor. If Pakistan did have a large LWR in operation in the 1990's, it probably would have to import fabricated nuclear fuel, thus increasing its dependence upon external nuclear suppliers.

In summary, Pakistan by the 1990's probably could have a domestic supply of plutonium enough to make a few nuclear explosives a year, assuming nothing was done to stop it. As for highly enriched uranium, the prospects appear less that Pakistan by then could successfully complete and operate an enrichment facility. So Pakistan could be in a position to test a plutonium device before the decade is out and to start production of a small arsenal thereafter. Again, this assumes that no countermeasures are taken by other countries, or that they are ineffective; and that Pakistan's weapons development can keep pace with the likely timing for a supply of plutonium.

In Summary

Looking at India, Iraq, Libya and Pakistan together in terms of their present potential for attaining a nuclear weapons capability, it

appears that at the moment India already has demonstrated its capability to develop, design, make and test a nuclear device, including production of weapons grade plutonium. None of the other three appear to have supplies of nuclear materials on hand to make nuclear weapons or facilities to produce these materials. Pakistan could be close to capacity to reprocess some spent fuel from its heavy water reactor. Iraq does have some highly enriched uranium on hand from its now destroyed research reactor. However, if this were diverted, at best it could provide material only for one device. As for the comparative nuclear weapons potential of these states, these are compared in table IV, which indicates that India is closest to a weapons capability, followed by Pakistan and then at some distance by Iraq and Libya.

Looking ahead to 1990, India by then should have an increased supply of plutonium and might have some uranium–233 also, but no highly enriched uranium. Pakistan could have a small supply of plutonium and maybe some enriched uranium. Iraq and Libya, however, probably would not be much closer to a supply of these weapons materials than they are today unless they receive strong technical assistance and equipment from external sources. It should be kept in mind that this comparison does not try to guess the ability of Iraq, Libya and Pakistan to develop, design and test nuclear weapons, nor their intentions. Logic, however, suggests that their target dates to acquire this capability would coincide with their target dates for acquisition of their own supplies of weapons grade materials.

TABLE IV.—INDIA, IRAQ, LIBYA, AND PAKISTAN: THEIR CLOSENESS TO NUCLEAR WEAPONS ARSENAL: AN ILLUSTRATIVE COMPARISON

Nuclear asset	India	Iraq	Libya	Pakistan
Trained scientists, engineers, and technicians	3	1	1	2
Universities with nuclear instruction	3	0	0	2
Nuclear research centers	3	1	1	2
Uranium resources	3	0	[1]1	2
Inventories of:				
Plutonium	2	0	0	0
Highly enriched uranium	0	2	0	0
Enrichment capacity	0	0	0	1
Plutonium production capacity:				
Research reactors (large)	2	0	0	0
Power reactors:				
Heavy water type	4	0	0	2
Light water type	2	0	0	0
Reprocessing capability	3	1	0	2
Heavy water capability	2	0	0	0
Total scores	27	5	3	13
Closeness to a nuclear arsenal (percent)[2]	56	9	6	27

[1] From Chad.
[2] In terms of basic resources needed, but excluding ability to design and make weapons.

Scoring system: 4=excellent; 3=good; 2=some; 1=developing; 0=inconsequential or unknown. Maximum score, 48.

ISSUE 4: THE SOURCE COUNTRIES WHICH SUPPLY INDIA, IRAQ, LIBYA AND PAKISTAN, AND THE EXTENT OF RELIANCE BY THESE SUPPLIERS UPON THE UNITED STATES FOR NUCLEAR FUEL

Summary

Some 15 nations in addition to the United States have supplied various kinds of nuclear assistance and exports to one or more of the four countries with which we are concerned—India, Iraq, Libya and Pakistan. Table V summarizes the situation. The kinds of assistance provided have included training of personnel and technical advice; supply of nuclear power reactors, equipment, and fuel; and supply of non-nuclear items which nonetheless are useful for the construction of enrichment and reprocessing plants. The reliance of these supplier countries upon the United States varies from one to another. Except for the Soviet Union, these supplier countries have had some nuclear exports from the United States at one time or another. At present their reliance upon the United States as a nuclear supplier is limited mainly to uranium enrichment services. With the impending completion of Eurodif and with the entry of the Soviet Union into the world enrichment market, this reliance will be less in the future. As for U.S. supply of nuclear power reactors, the industry hopes for some future exports to Spain and perhaps to Argentina. On the other hand the Soviet Union, France and West Germany all are now suppliers of nuclear power reactors, with the latter two strongly competing with the United States for sales within the non-Communist world. In no instance is any one of these supplier countries wholly dependent upon U.S. nuclear supplies. So at the outset of the 1980, the United States faces a situation where there are several major alternative nuclear suppliers for those countries that we would prefer to keep distant from nuclear power or, at least, distant from a domestic capacity to produce highly enriched uranium or plutonium. The dependence of some suppliers upon the United States for enrichment services is becoming less as time goes by. Within a few years they can be virtually independent of the United States, unless there is an unexpected spurt in their nuclear power and a corresponding jump in their demand for enrichment.

TABLE V.—NUCLEAR SUPPLIERS TO INDIA, IRAQ, LIBYA, AND PAKISTAN, 1978-81

Supplier State	Importing State			
	India	Iraq	Libya	Pakistan
Argentina			×	
Brazil		×		
Finland			×	
Federal Republic of Germany		×		×
France	×	×		×
India			×	
Italy		×		×
Netherlands				×
Niger		×	×	×
Norway				×
Portugal		×		
Spain				×
Switzerland				×
Turkey				×
United Kingdom				×
United States	×		×	×
U.S.S.R.	×	×	×	

SOURCES, METHOD AND APPROACH

The analysis of this issue is divided into two parts. Part I identifies the nuclear suppliers of India, Iraq, Libya and Pakistan, and the kinds of items supplied. Part II addresses the reliance of these suppliers upon the United States for nuclear fuel and other supplies.

Both analyses are based upon information in the open literature, including major American newspapers, foreign news items (as reprinted by the Foreign Broadcast Information Service in its series on nuclear development and proliferation), the British periodical Nuclear Engineering International, the American periodical Nuclear News, and the newsletter Nucleonics Week. The years covered were limited to 1978 to date, both to focus upon recent patterns of supply and also to keep the research manageable. Even within this brief span, some suppliers have terminated their supplies to the four states under consideration. The authors made some inquiries of the Departments of State and Energy, the Arms Control and Disarmament Agency and the Nuclear Regulatory Commission. These agencies held that information beyond that in the open literature could not be had from them because it was classified.

The dependence of the analyses upon the open literature has the advantage that its information can be freely discussed without fear of disclosing classified information. On the other hand, it is likely that access to information held by Federal agencies, especially intelligence information, might have changed parts of the analyses and their conclusions.

Our information search turned up no statistical compilations of world nuclear exports to various countries. Consequently, the analyses have to depend upon examples of nuclear supplies to India, Iraq, Libya and Pakistan rather than upon comprehensive statistical information. Nuclear supplies were defined broadly to include nuclear technology, nuclear training and education; nuclear equipment, parts and materials; nuclear fuels; and items designed for non-nuclear uses that nonetheless could be used to make nuclear facilities, i.e. the so-called dual-use items.

Analysis: Part I.—Nuclear Suppliers of India, Iraq, Libya, and Pakistan

India's nuclear suppliers

India has received substantial foreign assistance for its nuclear power program. The 40 megawatt Canada-India Reactor (CIR), which is a high neutron flux unit patterned after Canada's powerful NRX reactor, was built under Canadian technical direction. Canada made a major contribution toward the cost of the installation pursuant to an agreement with India within the framework of the Colombo Plan for Asian economic development. The United States provided two nuclear power reactors at Tarapur and the U.S. Atomic Energy Commission supplied heavy water for India's CIR reactor and enriched uranium to fuel the Tarapur reactors. Later the Canadians provided a power reactor of the natural uranium, heavy water type, and collaborated with Indian industry in design and construction of a second. India is now designing and building its own nuclear power plants. By the late 1960, India had begun design and construction of heavy water plants in collaboration with the French and West Germans. However, it still cannot produce enough to supply its needs. Later, the French began to help India's development of a fast breeder test reactor.

While India is now closer to nuclear independence than many nations, it continues to receive nuclear materials and assistance from the Soviet Union, some European countries and, until recently, the United States.

France and West Germany.—It was reported in 1978 that components from Europe were ordered for India's Baroda heavy water plant.[133] All but one of their plants were built with French and German assistance.[134]

In addition, the French are reportedly involved in India's fast breeder project at Kalpakkam. France's CEA is collaborating in the construction of the reactor and reportedly agreed to provide its enriched uranium fuel.[135] However, the CEA apparently has had afterthoughts, and there have been no published report of any such French supply.

U.S.S.R.—A reported Indo-Soviet understanding reached in June 1979 involved Soviet technology transfers and possibly financial assistance to India for factories to produce nuclear reactors, containment vessels, and heat exchangers.[136] The Soviet Union has also supplied India with some heavy water. A contract for 200 tons was reported to have been signed in 1976.[137] And, in 1980, a new agreement was reported, calling for the Soviets to supply an additional 250 tons, 30 tons of which reached India in May 1980.[138]

Furthermore, there have been reports that Indian scientists and technicians are working at nuclear energy institutions in the U.S.S.R.

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[133] Nuclear Engineering International, September 1978, p. 11.
[134] Nuclear Engineering International, January 1978, p. 9.
[135] Nuclear Engineering International, June 1979, p. 9.
[136] Nuclear Engineering International, October 1979, p. 12.
[137] Nuclear Engineering International, July 1980, p. 3; see also NEI, February 1978, p. 9, and April 1978, p. 8.
[138] Nuclear Engineering International, July 1980, p. 3; see also NEI, September 1980, p. 4, and October 1980, p. 10.

Of interest also is a reported Soviet offer of a 1000 MWe nuclear powerplant, which India declined, and uranium enrichment services.[139]

United States.—The United States has helped to train Indian engineers and physicists. According to data provided by the National Science Foundation between 1958 and 1976, 2,492 Indian nationals received doctorates in engineering and 652 in physics in the United States. In 1976 alone, there were 214 doctorates in engineering and 43 in physics awarded by U.S. institutions to Indian nationals.[140]

Indo-American nuclear trade in 1980 and 1981 has consisted of shipments of enriched uranium and some replacement parts for the two Tarapur reactors. India also purchased some heavy water from the United States. Export license applications are now before the Nuclear Regulatory Commission for more heavy water, certain nuclear components, and more enriched uranium.[141] As noted earlier, it appears unlikely that these licenses will be issued. U.S. supply of enriched uranium to India now appears to have stopped. U.S. nuclear cooperation is about to be terminated because of India's refusal to agree to the full scope safeguards required by the Nuclear Non-Proliferation Act of 1978.

IRAQ'S NUCLEAR SUPPLIERS

Nuclear development in Iraq has depended heavily on foreign assistance. Its research center, the Tuwaitha Atomic Center, with its laboratory facilities was built with western funds when Iraq was a member of the Baghdad Pact. A small research reactor there was supplied by the Soviet Union, which also installed and operated a laboratory for processing of radioisotopes. Since the mid 1970's, the French have become Iraq's main nuclear supplier. Other supplier countries have included Italy, Portugal, Brazil, Niger, Spain and West Germany. All have supplied or agreed to supply Iraq with various items of nuclear technology, materials and/or training.

Brazil.—Iraq reportedly signed an agreement for nuclear cooperation with Brazil in 1980. It provides for transfer of Brazilian technology on the exploration and treatment of uranium, for nuclear equipment, for the construction of reactors, and for personnel training.[142] Recently there have been reports that Brazil already has surreptitiously supplied uranium dioxide to Iraq.[143] Iraq has denied these reports.[144]

Federal Republic of Germany.—Iraq has reportedly obtained 10 tons of natural and depleted uranium from the FRG.[145]

France.—Under the terms of a 1975 accord for nuclear cooperation, France began constructing the Tuwaitha nuclear research center with

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[139] Nuclear Engineering International, May 1979, p. 4; see also NEI, June 1979, p. 9.

[140] U.S. Nuclear Regulatory Commission, nuclear export and import licensing actions taken by the NRC, May 1981. Report of licenses by pending status, pp. 18, 21–23.

[141] Mark Wolfe, discussion of enrollment data on foreign nationals from India and Pakistan engineering on physics programs in the United States and Western Europe, of Appendix II.

[142] Oestado de Sao Paulo (Sao Paulo), Jan. 25, 1980, p. 5. Text in Worldwide report: nuclear development and proliferation, No. 33, Mar. 4, 1980, pp. 5–6. See also, Oestado de Sao Paulo, Jan. 9, 1980, p. 6, and Jan. 11, 1980, p. 5. Text in Worldwide report: nuclear development and proliferation, No. 29, Feb. 12, 1980, pp. 26–28.

[143] The Guardian, June 13, 1981, p. 6. Text in Worldwide report: nuclear development and proliferation, July 22, 1981, pp. 1–2.

[144] INA (Baghdad), July 7, 1981. Text in Worldwide report: nuclear development and proliferation, No. 106, July 22, 1981, p. 4.

[145] Paul Lewis, "Stockpiling of Uranium Reported by Iraq Before the Raid." New York Times, June 19, 1981, p. A10.

its two research reactors, the larger of which was the target of the June 7 Israeli raid. If completed, the center could train some 600 Iraqi nuclear scientists and engineers at one time. In addition, France agreed to provide some 70 kg of 93 percent enriched uranium to fuel the reactors.[146] It had delivered 12 to 13 kg to Iraq before the raid.[147] At present, the future of France-Iraqi nuclear relations is uncertain. A recent news report indicates that France and Iraq had agreed to open talks in Paris in mid August on reconstruction of the Tammuz research reactor.[148] Other reports indicate that Saudi Arabia is willing to finance the rebuilding.[149]

Italy.—Italy reportedly has been building some nuclear research facilities at Iraq's nuclear research center, including radioisotope and radiochemistry laboratories and fuel fabrication and chemical engineering facilities. In addition, Italy has agreed to train Iraqi nuclear scientists and technicians.[150] Iraq also is reported to have talked with Italy about the purchases of a large heavy water type power reactor.[151] While Italy has defended its nuclear cooperation with Iraq, after the raid the President of Italy's CNEN said that if Hussayn's June 23 statement about an Islamic bomb was verified Italy should terminate nuclear cooperation with Iraq.[152]

Niger.—Iraq has reportedly received 100 tons of uranium yellow cake from Niger.[153]

Portugal.—It is reported that Portugal provided 120 tons of uranium yellow cake to Iraq in 1980, and will provide an additional 130 tons in 1981.[154]

Spain.—A confidential nuclear agreement between Iraq and Spain has been reported. Whether this provides for the transfer of nuclear technology, materials, or training is not known.[155]

U.S.S.R.—The Soviet Union supplied Iraq with a small nuclear research reactor (which was activated in 1968), the fuel to operate it, and associated small-scale laboratories.

LIBYA'S NUCLEAR SUPPLIERS

Libya's nuclear program is only now coming into being, primarily with assistance from the U.S.S.R. Niger has been an important supplier of uranium and over the years some assistance has come from Argentina, India, Finland, and the United States. Moreover, a Pakistani-Libyan nuclear connection has often been reported.

Argentina.—Argentina has agreed to provide Libya with equipment and techniques for finding, extracting, and purifying uranium.[156]

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[146] Science, Aug. 29, 1980, p. 1001.
[147] Nuclear Engineering International, December 1980, p. 1.
[148] The Wall Street Journal, Aug. 10, 1981, p. 15.
[149] The Washington Post, July 17, 1981, p. A1.
[150] Richard Burt, "Iraq Said to Get A-bomb Ability With Italy's Aid," New York Times, Mar. 18, 1980, pp. A1, A8.
[151] The Energy Daily, Sept. 26, 1980, p. 1.
[152] Nucleonics Week, July 9, 1981, p. 3.
[153] Paul Lewis, "Stockpiling of Uranium Reported by Iraq for Years Before the Raid," New York Times, June 19, 1981, p. A10.
[154] "Portugal to Sell Iraq Unenriched Uranium," Washington Post, July 17, 1981, p. A18. See also The Working People's Daily (Rangoon), Apr. 9, 1981, p. 3. Text in Worldwide report: nuclear development and proliferation, No. 97, May 27, 1981, p. 1.
[155] New Scientist, Aug. 28, 1980, p. 635.
[156] The Arab World Weekly (Beirut), Jan. 24, 1981, pp. 3–5. Text in Worldwide report: nuclear development and proliferation, No. 84, Mar. 3, 1981, p. 36.

Finland.—Libyan students have studied electrical and nuclear technology at the National Technical Research Center in Ottaniemi.[157] Also Finland has shown interest in helping in the construction of a nuclear powerplant that may be supplied by the U.S.S.R.[158]

India.—Libya has an agreement with India for the training of Libyans at Indian nuclear facilities.[159] It has been also reported that India and the Soviet Union might collaborate in constructing a nuclear power facility in Libya.[160] The status of this joint project is unknown.

Niger.—Niger recently sold 450 tons of uranium yellow cake to Libya.[161]

U.S.S.R.—The Soviets are reportedly constructing a nuclear research center in Libya. Its centerpiece is to be a 10 MWe Soviet research reactor.[162] The center is to include associated laboratories about which little information is available. The nuclear materials for the center will be supplied by the Soviet Union and direct Soviet participation in operation of the center reportedly is being considered.[163]

For years there have been reports of Libyan talks with the Soviet Union about a nuclear powerplant. As late as May 1981, talks were reported about the supply of two standard 440 MWe export type power reactors.[164]

United States.—U.S.-Libyan nuclear relations have been limited to study here of nuclear science by Libyan nationals. In 1978, it was reported that there were some 200 Libyan students in this field in U.S. universities.[165]

PAKISTAN'S NUCLEAR SUPPLIERS

During the early years of Pakistan's nuclear program, the United States and Canada were its principal suppliers. The Canadians provided a small, heavy water type power reactor, uranium, and technical assistance. The United States initially provided a research reactor and some heavy water. Neither country is now a nuclear supplier to Pakistan. Pakistan also has received nuclear assistance and or imports from the Federal Republic of Germany, France, Italy, the Netherlands, Niger, Norway, Spain, Switzerland, Turkey and the United Kingdom. Most of the transactions were small. Nonetheless, they show the breadth of sources available to Pakistan's nuclear efforts.

Federal Republic of Germany.—West Germany has reportedly provided Pakistan with a uranium hexafluoride plant.[166] It is not clear how much Pakistan depends upon the Germans for operating parts and supplies, or what is the status of this plant. In addition, West German firms have reportedly provided aluminum rods, vacuum pumps, and other equipment.[167]

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[157] Hufvudsbladet (Helsinki), Oct. 24, 1980, p. 19. Text in Worldwide report: nuclear development and proliferation, No. 70, Nov. 14, 1980, pp. 35–36.
[158] Nucleonics Week, Mar. 27, 1980, p. 14.
[159] Nuclear Engineering International, November 1979, pp. 7–8.
[160] Nuclear Engineering International, April 1980, p. 7.
[161] Journal of Commerce, Apr. 15, 1981, p. 35.
[162] AFP (Paris), Jan. 7, 1981. Text in Worldwide report: nuclear development and proliferation, No. 79, Jan. 26, 1981, p. 58.
[163] Nucleonics Week, May 7, 1981, pp. 5–6.
[164] Ibid., p. 6.
[165] Science, December 1978, p. 1264.
[166] Stern, July 2, 1981, pp. 96–99.
[167] Ibid.

France.—French firms have sold the Pakistans equipment for potential use in Pakistan's reprocessing plants, including items such as dissolvers, evaporators, mixer-settlers, and special vessels.[168] As well, Pakistan has purchased spectometry equipment from France.[169]

Italy.—Special steel vessels were sent to Pakistan by an Italian firm that is a subsidiary of the French SGN.[170]

Netherlands.—Two Dutch firms have sent sensitive equipment to Pakistan, including 6,200 tubes of special steel.[171]

Niger.—Niger has sold 110 tons of uranium yellow cake to Pakistan.[172]

Norway.—A government owned Norwegian company has supplied zirconium tubes.[173]

Spain.—During the spring of 1981, the Pakistan Atomic Energy Commission awarded the first phase of the design of a nuclear power station to Sener Engineering and Systems, which is Spain's leading consulting engineering firm. The nuclear powerplant is to be built at Chashma. It is to be a light water reactor with a power level of either 600 or 900 MWe. Phase one includes the review and updating of the main specifications, basic design and engineering, a review of the cooling systems, a quality assurance program and budget studies.[174]

Switzerland.—Swiss firms have supplied Pakistan with parts and equipment thought to be for its enrichment project. Items reportedly included evaporators, condensers, electrical inverters and quality-control equipment.[175] In addition, a Swiss firm is reported to have sold special French filters to Pakistan.[176]

Turkey.—Turkish firms reportedly have been reselling U.S. supplied electrical inverters from Europe to Pakistan.[177] Presumably these are for the enrichment project.

United Kingdom.—British firms reportedly sold the Pakistanis 31 electrical inverters and a metal finishing plant.[178]

United States.—While the United States is not now a notable nuclear supplier of Pakistan, in the years following President Eisenhower's Atoms for Peace address of 1953, there was U.S. nuclear cooperation. An agreement covering exchange of unclassified information on design, construction and operation of research reactors was concluded with Pakistan during 1955. It expired by mutual agreement in 1960 with the expectation that Pakistan would seek further nuclear assistance from the International Atomic Energy Agency.

During the early years, a U.S. company designed the Institute of Nuclear Science near the new capital city of Islamabad. Another U.S.

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[168] Foreign Report, 1635, June 18, 1980, p. 2.
[169] Richard Pollock, "The Islamic Bomb," Critical Mass Journal, July 1980, p. 15.
[170] Nucleonics Week, Dec. 4, 1980, p. 10.
[171] Nuclear Engineering International, April 1980, p. 6; Nuclear News, April 1980, p. 67.
[172] Nuclear Engineering International, February 1980, p. 11; Nuclear News, February 1980, p. 91.
[173] Aftenposten (Oslo), Apr. 10, 1980, p. 24. Text in Worldwide Report: nuclear development and proliferation. Text in Worldwide report: nuclear development and proliferation, No. 49, June 25, 1980, pp. 1–2.
[174] Nuclear Engineering International, May 1981, p. 4.
[175] Nuclear News, February 1981, p. 56. Richard Burt, "Nuclear Issue Mars Ties with Swiss," New York Times, Sept. 23, 1980, p. A4.
[176] Le Point (Paris), Jan. 7, 1980, p. 27. Text in Worldwide report: nuclear development and proliferation, No. 31, Feb. 21, 1980, p. 3.
[177] Barry Schweid, "Turks Ship U.S. A-Tools to Pakistan," Washington Post, June 28, 1981, pp. A1, A16.
[178] The Times of India (Bombay), Dec. 31, 1980, pp. 1, 15. Text in Worldwide report: nuclear development and proliferation, No. 82, Feb. 10, 1981, pp. 36–37.

company supplied a 5 MWt pool type reactor that was financed in part by $350,000 from the U.S. Atomic Energy Commission under its program of Foreign Research Reactor Grants. In 1961, two U.S. firms were retained to study the economic feasibility of constructing one or more nuclear power plants in Pakistan.[179]

During the 1970's there were some minor U.S. exports of nuclear materials to Pakistan involving small quantities of uranium, thorium, plutonium and about 22 kg of heavy water.[180] Also, many Pakistanis have received nuclear training in the United States during the 1960's and 1970's, both in special programs and in U.S. universities.[181]

The only U.S. nuclear export to Pakistan during the last 3 years involved less than one gram of plutonium in 1978.

Pakistan's efforts to acquire reprocessing and enrichment facilities have created strains in its relation with the United States. Certain U.S. military and economic aid was cut off because it was importing parts for its reprocessing effort. This aid was later resumed. More recently, in 1979, this aid was again cutoff because of Pakistan's imports of equipment to build an enrichment facility. That cutoff is still in effect, although the Reagan administration would waive it so that U.S. military and economic aid can be resumed to strengthen Pakistan against the Soviet Union. The basis for these cutoffs was the Symington amendment to the Foreign Assistance Act by Public Law 95–52 of August 4, 1977.

Analysis: Part II.—Dependence of Nuclear Supplier States on the United States

SUMMARY

Some 16 states, including the United States at one time or another during the last 3 years have provided some nuclear supplies to India, Iraq, Libya and Pakistan. Information in the open literature indicates the supply relations shown in table V. Items supplied have included nuclear technology, materials, equipment, facilities, training and education, and so called dual-use items which although designed for nonnuclear applications may have use in the construction and operation of nuclear facilities.

Exports for nuclear materials and heavy water licensed during 1980–81 are summarized in table VI.

The United States is not a large supplier of natural uranium to other countries. Many countries that buy U.S. enrichment services supply the required uranium from other sources, which can include Canada, several African nations, and, in the future, Australia.

The nuclear assistance supplied by the United States does not presently include storage and reprocessing of spent fuel from power reactors, although spent fuel containing residual highly enriched uranium from research reactors has been returned here. While the Nuclear Non-Proliferation Act of 1978 clearly contemplates some U.S. storage or disposition of spent fuel from abroad, this authority was not exercised

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[179] John F. Hogerton, ed. "The Atomic Energy Deskbook." New York: Reinhold Publishing Corp., 1973, p. 382.

[180] U.S. Department of Energy. U.S. exports of nuclear materials to Pakistan during the period Jan. 1, 1970 through Oct. 31, 1979.

[181] Warren H. Donnelly. Analysis of ERDA information on U.S. nuclear assistance to Pakistan. CRS memorandum, Dec. 27, 1977, pp. 1–3.

by the Carter administration, and it appears that the Reagan administration will not use it either. As for reprocessing, while the Department of Energy operates large reprocessing plants as part of its nuclear weapons program, these are not available for commercial work and could not handle commercial reactor fuel without extensive modification. A large commercial reprocessing plant at Barnwell, S.C., has not yet obtained an NRC operating license and may be dismantled.

ANALYSIS

The analysis in Part II draws heavily upon the periodic reports of the Nuclear Regulatory Commission on nuclear export and import licensing actions. These reports were examined for the period January 1, 1980 through February 28, 1981, which is long enough to indicate the kinds of items that supplier states have recently obtained from the United States. The information gives some indication of their independence upon U.S. supply and the potential influence, or leverage, the United States could exert through a threat to stop such supplies. Information on export licenses pending in June 1981 came from Nuclear Fuel issue of June 8, 1981.

The analysis briefly examines U.S. nuclear assistance for each country identified in Part I as having supplied nuclear items to India, Iraq, Libya or Pakistan. It should be kept in mind that most of the U.S. exports are individual transactions unless otherwise indicated. Also, the analysis assumes that items licensed for export by the NRC were indeed shipped, which is a reasonably safe assumption for most items, especially nuclear materials. While most NRC licenses for nuclear export identify specific items, some licenses—particularly for a complete nuclear steam supply system—may involve many deliveries spread over several years after issuance of a license.

TABLE VI.—U.S. EXPORTS OF NUCLEAR FUEL MATERIALS AND HEAVY WATER LICENSED TO COUNTRIES THAT HAVE BEEN NUCLEAR SUPPLIERS TO INDIA, IRAQ, LIBYA, AND PAKISTAN: JAN. 1, 1980 TO FEB. 28, 1981

Country	Natural uranium (kilograms)	Enriched uranium		Plutonium (kilograms)	Heavy water (kilograms)
		Quantity	Degree of enrichment [1]		
Argentina		5.4	Low/medium		16.0
Brazil		1.0	High/medium		16.1
Finland		(2)	Various		10.0
Federal Republic of Germany	615,578	650,143.0	Low	(2)	5.0
		30.0	Low/medium		
		22.0	High/medium		
		80.0	High		
France	70,498	61,628.0	Low		30.0
		32.0	Low/medium		
		33.0	High/medium		
		83.0	High		
India		39,717.0	Low		48.0
Italy	30	4.0	Low/medium	(2)	15.0
			Various		
Netherlands		25,330.0	Low		
		40.0	Low/medium		
		40.0	High		
Niger					
Norway				(2)	
Portugal					
Spain		51.0	Low/medium		
Switzerland		52,441.0	Low		
		4.0	High/medium		10.0
United Kingdom	4,000,093	35.0	Low	37	56.0

[1] Degrees of enrichment: Low—2 to 10 percent; low/medium—19 to 20 percent, high/medium—45 to 50 percent, high—93 to 94 percent.
[2] Less than 0.1 kg indicated.

Source: U.S. Nuclear Regulatory Commission reports.

U.S. nuclear assistance to nuclear suppliers for India, Iraq, Libya and Pakistan

Argentina.—The United States has an agreement for nuclear cooperation with Argentina that extends to July 24, 1999. It has yet to be renegotiated by the United States as is required by the Nuclear Non-Proliferation Act of 1978. NRC licenses during 1980–81 have authorized export of small amounts of enriched and depleted uranium, some heavy water and some other nuclear materials. Details appear in table VI. As of June 1981, license applications were pending for export of 12 kg of 90.4 percent enriched uranium and 50 kg of material with 19.9 percent enrichment.

Brazil.—The United States has an agreement for nuclear cooperation with Brazil that extends to September 19, 2002. It has yet to be renegotiated. NRC export licenses during 1980–81 covered small amounts of heavy water. Pending before NRC in June 1981 were license applications for 1,726 kg of 3.45 percent enriched uranium and 16,242 kg of uranium with 3.35 percent enrichment for Brazil's Angra-1 nuclear power plant.

Finland.—The United States has an agreement for nuclear cooperation with Finland extending to July 6, 2000. It has yet to be renegotiated. Export licenses in 1980 and 1981 covered heavy water, miscellaneous parts for a nuclear installation, and some neutron detectors. No export applications were pending in June 1981.

France.—U.S. nuclear cooperation with France is through the U.S. agreement with Euratom which extends until December 31, 1985. Renegotiation of this agreement appears to be at an impasse.[182] Licensed nuclear exports to France during 1980–81 covered relatively large amounts of nuclear materials including enriched, natural and depleted uranium and heavy water. Licensed exports of some minor supplies covered such items as ionization chambers, proportional counters and fission chambers.

As of June 1981, seven license application for exports of enriched uranium to France were pending before the NRC as follows:

Quantity (kilograms)	Enrichment (percent)	Elapsed time since license application (months)
33	93.3	24
26	93.5	23
15	93.3	23
60	93.3	23
26	93.3	23
26	93.5	7
11,165	4.3	1

Source: NRC.

The Federal Republic of Germany.—As with France, U.S. nuclear cooperation with the Federal Republic of Germany is through its agreement with Euratom. During 1980–81 export licenses authorized shipment of large amounts of enriched uranium, natural uranium,

[182] The impasse appears to be over the act's requirement that Euratom agree to get the prior approval of the United States before reprocessing nuclear materials covered by any new agreement. The present Euratom agreement does not have this requirement.

and heavy water. Smaller quantities of plutonium, thorium and other nuclear materials were licensed. As for components, export licenses were issued for items such as ionization chambers, gamma chamber, zirconium tubing, tube shells and fuel channels, neutron detectors, and fuel element hardware.

As of June 1981, 10 nuclear export license applications were pending for export of enriched uranium to West Germany that covered the following items:

Quantity (kilograms)	Enrichment (percent)	Elapsed time since license application (months)
2.37	93.3	28
55	51.2	44
5.7	5.34	42
6.82	93.3	28
11.3	93.3	15
103.26	93.3	13
15,350	2.85	8
64.7	45.3	2
31.3	93.3	2
7.9	93.3	New

Source: NRC.

India.—The United States has an agreement for nuclear cooperation with India that extends to October 24, 1993. This agreement, however, is limited to cooperation involving India's Tarapur Atomic Power Station. Moreover, the State Department appears to be negotiating a termination of this agreement because India refuses to agree to the full scope safeguards requirement of the Nuclear Non-Proliferation act.

During 1980–81, U.S. exports were primarily enriched uranium for Tarapur and 48 kg. of heavy water. As of June 1981, an export license application for 19,858 kg of 2.71 percent enriched uranium had been before the NRC for 8 months.

Italy.—U.S. nuclear cooperation with Italy is through the Euratom agreement. Export licenses issued during 1980–81 covered small quantities of natural, enriched and depleted uranium; thorium, plutonium and heavy water. Other export licenses covered zirconium tubes and fuel channels, magnet assemblies, a radiation detector, a fission chamber and a proportional counter. As of June 1981, no export applications were pending for Italy.

The Netherlands.—Here again U.S. nuclear cooperation is via the Euratom agreement. Export licenses for 1980–81 covered large quantities of enriched uranium and some ionization chambers. As of June 1981, three export applications were pending covering a total of 44 kilograms of 93.3 percent enriched uranium.

Niger.—The United States has no agreement for nuclear cooperation with Niger. Consequently, there were no U.S. nuclear exports to that country.

Norway.—The United States has an agreement with Norway extending to June 7, 1997. A revision has been negotiated but had not been presented to the Congress by the time of writing. During 1980–81, export licenses covered some plutonium and zircalloy tube shells. No export license applications were pending in June 1981.

Portugal.—The United States has an agreement for cooperation with Portugal extending to June 25, 2014. It has yet to be renegotiated. No nuclear export licenses were issued during 1980–81 and no applications were pending as of June 1981.

Spain.—The United States has an agreement for nuclear cooperation with Spain that extends to June 27, 2014. It has yet to be renegotiated. During 1980–81, export licenses issued covered enriched uranium and nuclear components such as subcooler monitors, flexible metal hose, radiation detectors and seals for electrical penetration assemblies. Also during this time the NRC authorized amendment or extensions to four previous licenses involving the supply of six nuclear power reactors. As of June 1981, 10 licenses were pending for export of enriched uranium to Spain as follows:

Quantity (kilograms)	Enrichment (percent)	Elapsed time since license application (months)
88,636	3.25	47
73,173	3.15	46
147,708	3.2	43
64,600	3.2	43
71,803	3.72	33
2,774	3.2	21
2,774	3.2	21
115,000	3.7	18
239,500	3.9	27
96,000	3.8	17

Source: Nuclear Fuel, July 6, 1981, pp. 6–8.

Switzerland.—The United States has an agreement for nuclear cooperation with Switzerland that extends to August 7, 1996. It has yet to be renegotiated. During 1980–81, nuclear export licenses covered large amounts of enriched uranium, some depleted uranium, and some tritium. Licenses for nuclear components covered in-core detectors and zirconium fuel channels. No export license applications were pending in June 1981.

United Kingdom.—As with France, West Germany, Italy and the Netherlands, U.S. nuclear cooperation with the United Kingdom is through the Euratom agreement. The United States also has an agreement for military nuclear cooperation with the United Kingdom. During 1980–81, export licenses were issued for natural, enriched and depleted uranium; plutonium, thorium, tritium, heavy water, and other nuclear materials. Export licenses for nuclear included covered zircalloy tubing and an ion chamber. No export license applications were pending as of June 1981.

U.S.S.R.—The United States has no agreement for nuclear cooperation with the Soviet Union and consequently no export licenses have been issued.

CONCLUSION

Of the 16 countries that have supplied India, Iraq, Libya and Pakistan with one or another kind of nuclear supplies and assistance, 14 have received nuclear assistance and supplies from the United States. At the outset of the 1980's, none of these depend upon the United States for nuclear power reactors. Indeed, two of them—France and

the Federal Republic of Germany—are active competitors of the United States on the world nuclear power market. While most of them have imported many kinds of nuclear materials, parts and equipment, except for enrichment the transactions have been small. Cutoff of supply in the future would be more a nuisance than likely to cause a shutdown of their nuclear powerplants. Also, alternative supplies are available for most of the items presumably supplied by the United States. Cutbacks in European nuclear plans mean that Eurodif can supply a proportionately greater part of needed enrichment. Nonetheless, there is some dependence upon the United States for supply of enriched uranium, both low and highly enriched. Among the 14 countries, about six could feel a U.S. cutoff of exports of these materials. These include Argentina, Brazil, France, the Federal Republic of Germany, Spain and Switzerland. However, if a cutoff involved low enriched uranium to only one or two, Eurodif and the Soviet Union probably could replace a good part of the supply.[183] If U.S. exports of low enriched uranium were cutoff suddenly to all of these countries, it could cause delays in starting up new nuclear powerplants as these are completed and perhaps affect the operation of some existing nuclear powerplants.

Several of the supplier countries also import highly enriched uranium from the United States for test and research reactors. Since the United States retains a virtual monopoly for supply of this material, these countries would be more dependent upon the United States than they would be for supply of low enriched uranium.

On the whole, the only appreciable nuclear dependence of these supplier countries upon the United States which might be used to influence their future exports to India, Iraq, Libya and Pakistan is the supply of enriched uranium. That leverage is weakening as Eurodif increases its enrichment production and could be further weakened were Urenco to expand its enrichment capacity.

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[183] By early 1982, Eurodif is expected to be at full annual capacity of 10.8 million separative work units (SWU). At that time, it will be able to meet the fuel requirements for 80 nuclear powerplants of 1,000 MWe capacity. By the end of 1980, Eurodif had produced 6 million SWU. (Le Monde, May 15, 1981, p. 36). For comparison, the INFCE projection for U.S. enrichment capacity for 1982 is 21.6 million SWU/year.

ISSUE 5: POTENTIAL ALTERNATIVE SUPPLIERS OF NUCLEAR FUEL AND TECHNOLOGY TO NUCLEAR SUPPLIERS TO INDIA, IRAQ, LIBYA AND PAKISTAN

Summary

In addition to the United States and the Soviet Union, there are several major suppliers of nuclear fuel and technology. Among these, the principal possible alternatives to the United States include Canada, France, the Federal Republic of Germany, Italy and the United Kingdom. Among these, France, West Germany and Italy at one time or another have supplied some nuclear assistance to one or more of the four countries of present concerned—India, Iraq, Libya and Pakistan.

The one item of nuclear supply for which potential alternative supply remains uncertain is enrichment services. Although the United States no longer has a monopoly of enrichment supply among non-communist states, it remains a major supplier. France will be the principal alternative, especially after its Eurodif facility comes into full operation early in 1982.

Analysis

Although self-evident, it is worth recalling that the more a country depends upon external suppliers for its nuclear fuel and technology, the more influenced it is likely to be by their wishes, particularly if backed up by explicit or implicit threats of a cutoff. Such dependence can be reduced by seeking nuclear self-sufficiency, or by diversifying suppliers so that if one supplier threatens cutoff, another could take its place. The following analysis addresses potential alternative suppliers of nuclear fuel and technology for the 14 countries that (in addition to the United States and the Soviet Union) have provided some kind of nuclear assistance to India, Iraq, Libya or Pakistan. As shown in the analysis of Issue 4, these supplier countries include Argentina, Brazil, Finland, France, the Federal Republic of Germany, India, Italy, the Netherlands, Niger, Norway, Portugal, Spain, Switzerland, and the United Kingdom.

To illustrate possible alternative sources of nuclear fuels and technology, 10 potential supplier states were selected and compared in terms of the number of organizations offering selected major nuclear products and services listed in the Nuclear Buyer's Guide for 1981 as shown in Table VII. These items were chosen as major indicators of a capacity to supply nuclear fuels and technology. Five of the ten supplier countries examined have supplied some nuclear items to India, Iraq, Libya and/or Pakistan. Of these five, France, the Federal Republic of Germany, and Italy account for almost half of the listings in table VII.

On the whole table VII indicates that there are many sources among the principal nuclear supplier countries for nuclear fuels and technologies for India, Iraq, Libya and Pakistan.

TABLE VII.—NUMBER OF ORGANIZATIONS OFFERING NUCLEAR PRODUCTS AND SERVICES IN 10 NUCLEAR SUPPLIER COUNTRIES, 1981

Selected nuclear product or service	Argentina[1]	Belgium	Canada	France[1]	Federal Republic of Germany[1]	Italy[1]	Japan	Sweden	Switzerland[1]	United Kingdom	Total
Architect-engineer service	1	2	4	6	6	4	4	3	1	2	33
Engineer-constructors	2	1	5	9	3	4	5	.....	1	7	37
Fuel element fabrication	.....	2	3	6	3	2	5	1	.....	2	24
Fuel materials, general	.....	.....	2	5	4	1	1	1	.....	2	16
Fuel materials, mixed oxides	.....	2	.....	3	2	1	1	.....	.....	1	10
Fuel materials, plutonium	.....	2	.....	2	2	.....	1	.....	.....	.....	7
Heavy water	.....	.....	5	.....	.....	.....	.....	.....	.....	.....	5
Nuclear steam supply systems	.....	1	3	4	3	3	3	1	1	3	22
Reprocessing	.....	.....	.....	4	3	2	1	.....	.....	1	11
Spent fuel storage	.....	.....	.....	3	2	1	1	1	.....	1	9
Total	3	10	22	42	28	18	22	7	3	19	174

[1] A country that has supplied nuclear items to India, Iraq, Libya, or Pakistan.

Note: For some countries, the same organization may offer several products and services.

Source: Buyers Guide, 1981. Nuclear News, mid-March 1981.

Alternative to Dependence on the United States for Present Nuclear Supplies

At the heart of this issue is the ability of the United States to influence what controls other governments place on their nuclear exports through threats to cut off U.S. nuclear supplies and assistance. The following analysis looks into alternative sources for these nuclear supplier states for nuclear fuels, services, and products which they may have obtained or currently obtain from the United States.

Nuclear fuel: uranium.—Of the 14 supplier states, five including France, India, Niger and Spain have their own resources of uranium. Uranium suppliers other than the United States include Canada, several African countries and, in the future, Australia. Among these, Canada and Australia place nonproliferation conditions upon their supply, including full scope safeguards. African sources require only agreement to safeguard the materials supplied. Table VIII gives further detail on attainable uranium production for non-Communist countries as reported by the International Nuclear Fuel Cycle Evaluation in February 1980.

TABLE VIII.—INFCE PROJECTIONS OF ATTAINABLE URANIUM PRODUCTION CAPABILITY FOR NONCOMMUNIST COUNTRIES BY CONTINENT

[Metric tons of uranium per year]

	Amount	Projected
Africa	15,900	28,600
South Africa	6,500	10,600
Niger	4,300	10,500
Namibia	4,100	5,000
Gabon	1,000	1,500
Central African Republic	0	1,000

See footnotes at end of table.

TABLE VIII.—INFCE PROJECTIONS OF ATTAINABLE URANIUM PRODUCTION CAPABILITY FOR NONCOMMUNIST COUNTRIES BY CONTINENT—Continued

[Metric tons of uranium per year]

	Amount	Projected
Australia	600	12,000
Europe	4,330	6,460
France	3,450	4,020
Spain	680	1,270
Portugal	100	270
Italy	0	120
Germany (Federal Republic of)	100	200
Sweden	0	400
Yugoslavia	0	180
Asia	270	230
India [1]	200	200
Japan	30	30
Philippines	40	0
South America	700	1,650
Argentina	200	680
Brazil	500	970
Total (rounded)	50,000	98,000

[1] Estimate of NEA/IAEA working party on uranium resources.

Source: Fuel and heavy water availability. Report of Working Group 1. International Nuclear Fuel Cycle Evaluation. Vienna: International Atomic Energy Agency, 1980, p. 177.

More future sources of uranium may become available if recovery of uranium from phosphates turns out to be as economically attractive as recently reported by the Swiss analyst, S. Huwyler, of Switzerland's Federal Institute for Reactor Research.[184] If he is correct, seven countries in addition to the United States and Canada potentially could recover more than 100 tons of uranium a year from phosphoric acid plants as shown in table IX. A large potential for such production exists in countries such as Morocco that have large phosphate deposits. For comparison, a large, 1,000 MWe, nuclear powerplant fueled with low enriched uranium needs from 156 to 235 tons of uranium a year depending upon the enrichment process. Countries actively developing uranium extraction from phosphates include Belgium, Canada, France, Israel, Japan, Taiwan, the United States and Yugoslavia. Considering this development, and the present surplus uranium production capacity, alternative supplies should not be difficult to find.

Nuclear fuel: enrichment services.—Of the 14 supplier states plus the Soviet Union, all but one use nuclear powerplants fueled with slightly enriched uranium. The exception is Argentina which also uses natural uranium, heavy water moderated power reactors. Alternative suppliers for uranium enrichment services include Eurodif in France, Urenco, and the Soviet Union. In the future, additional alternative suppliers could include South Africa and a prospective combined Japanese-Australian venture. Table X shows INFCE's summary of enrichment availability in 1979. Table XI shows the enrichment capacity estimated for 1982 by the International Nuclear Fuel Cycle Evaluation. Data for 1982 is used because it includes a substantial increase in French capacity that is expected to be in operation early in that year, and so represents the situation for the near future.

[184] For a summary of his report, see Nuclear Engineering International, May 1981, p. 13.

While the United States no longer has the monopoly on enrichment supply to non-Communist states that it had until the Nixon administration, it remains a major supplier. France, however, is catching up and expects to have an annual enrichment capacity of 10 million SWU in operation early in 1982, in comparison with 12.7 million SWUs now available in the United States plus a commitment to expand to 14.7 million SWUs.

TABLE IX.—URANIUM POTENTIALLY RECOVERABLE FROM PHOSPHORIC ACID PLANTS

Country	Metric tons of uranium per year
United States	2,797
Canada	201
France	204
Italy	39
Netherlands	115
Spain	102
United Kindom	95
Yugoslavia	65
Iran	104
Japan	48
Korea	196
Lebanon	54
Morocco	210
Mexico	144
Total	4,380

Source: Nuclear Engineering International, May 1981, p. 13.

TABLE X.—INFCE: ENRICHMENT AVAILABILITY IN 1979

Country	Process					
	Gaseous diffusion	Gas centrifuge	Aero-dynamic	Chemical	Laser	Plasma
Australia		C			C	
France	A	C		B	C	
Germany, Federal Republic of		A [1]	B (Nozzle)		C	
Italy	B, C [2]	C			C	
Japan	C	B		C	C	
Netherlands		A [1]				
South Africa (Republic of)			A [4] (Helikon).			
United Kingdom	A	A [1]				
United States	A	B		C	C	C
U.S.S.R	A [3]					

[1] Joint trinational Urenco Centec plants: Troika.
[2] B: In the frame of its participation in Eurodif. C: In the frame of its national program.
[3] No answers were supplied to the INFCE questionnaire; data were inferred from information published elsewhere.
[4] No answers were supplied to the INFCE questionnaire but data were obtained from correspondence.
Abbreviations:
A—Annual capacity: 100,000 SWU/year or more, typical for production.
B—Annual capacity 1,000-100,000 SWU/year, typical for industrial development.
C—Annual capacity less than 1,000 SWU/year, typical for laboratory and pre-industrial demonstration.

Note: Where no information appears, INFCE received no answers to its questionnaire on enrichment.

Source: Enrichment availability. Report of Working Group 2. International Nuclear Fuel Cycle Evaluation. Vienna: International Atomic Energy Agency, 1980, p. 5.

TABLE XI.—INFCE PROJECTION OF ENRICHMENT CAPACITY FOR 1982

[Million SWU per year]

Country	In operation	Committed	Total
France	2.2	8.6	10.8
Japan		.05	.5
Urenco	.4	.6	1.0
U.S.S.R	4.0		4.0
United States	12.7	8.9	21.6

Source: Enrichment availability. Report of Working Group 2. International Nuclear Fuel Cycle Evaluation. Vienna: International Atomic Energy Agency, 1980, pp. 74-75.

INFCE's working group on enrichment concluded that present enrichment capacities under operation or construction would cover projected needs until after 1995. Beyond 2000, enrichment to meet the most optimistic INFCE nuclear power forecasts would require a rapid expansion of capacity.[185] On the other hand, if forecasters who project nuclear power growth considerably less than did INFCE are correct, enrichment capacity in being and under construction would provide a surplus with significant implications for sources of alternate supply. Two other conclusions from INFCE concerning enrichment supply are worth noting:[186]

> The technical and economic viability of certain enrichment technologies is well established. Individual technologies have been independently developed to industrial scale application in several countries. The lead times for installation are sufficiently short not to hamper meeting the requirements of a growing nuclear energy program. Several other technically proved technologies are at a less advanced state of development but offer good prospects for future industrial application.

And

> The supply possibilities have diversified as new enrichment suppliers (Eurodif, Technabexport and Urenco) have entered the market as hampered competitors. . . .

Nuclear technology: nuclear steam supply systems.—The highest form of a nuclear technological export is a complete nuclear steam supply system. Table VII indicates countries in addition to the Soviet Union and the United States capable of supplying such system. These include Belgium, Canada, France, the Federal Republic of Germany, Italy, Japan, Sweden and the United Kingdom. Of these France and the Federal Republic of Germany are the strongest competitors of the United States in the world market. The 14 countries which have supplied some nuclear assistance to India, Iraq, Libya or Pakistan could readily find in France, West Germany, and other countries a supply of nuclear powerplants if they need an alternative to the United States. Likewise, they could probably turn to them for assistance in applying nuclear power technology, training personnel, and building and operating complete nuclear powerplants.

Suppliers for Services Not Now Available From the United States

Assuming that nuclear power abroad continues to grow and that nuclear fuel is reprocessed, two nuclear services likely to have an international market are reprocessing and spent fuel storage. While the United States offers neither at this time, it is possible that such U.S. services might be offered in the future. These are mentioned because each, if developed, could provide the United States with some further influence, or "leverage," for countries needing these services while decreasing the influence of alternative suppliers who presently enjoy a monopoly.

Fuel reprocessing services.—Unless other countries follow the lead of United States policy under the Carter administration and refrain from reprocessing spent fuel, nuclear power reactors, many countries

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[185] Enrichment availability. Report of working group 2. International Nuclear Fuel Cycle Evaluation. Vienna: International Atomic Energy Agency. 1980, p. 29.
[186] Ibid. Note. Technabexport refers to the Soviet nuclear marketing organization.

are likely to want reprocessing services. While the Department of Energy operates the world's largest reprocessing plants, these are for production of nuclear weapons. They never have been available to reprocess commercial nuclear fuel, are unlikely to become available, and would have to be modified substantially to process commercial fuel. So the United States can offer no commercial reprocessing service. A commercial plant was completed in Barnwell, S.C., but is unlikely to be given an operating license by the Nuclear Regulatory Commission. Moreover, it will probably be scrapped by its owners unless the Government buys it, which is not expected under the Reagan administration.

As for commercial sources abroad, both France and the United Kingdom offer a combination of spent fuel storage and reprocessing services, and both are working to expand their reprocessing plants. However, the ultimate technical and economic feasibility of their efforts remains to be seen. India's reprocessing capability is so small that it would be an unlikely supplier to other countries. Some other countries also have small capacities as shown in table XII. Looking ahead, the Japanese are planning a commercial size reprocessing plant, but it is not known whether it would service foreign spent fuel.

Spent fuel storage.—The idea of reducing nuclear weapons risks by storing rather than reprocessing of spent fuel requires long term spent fuel storage service. At present no free world country offers such a service. The Soviet Union requires the return of spent fuel from its satellites, but not from non-Communist buyers of its enrichment services. The Nuclear Non-Proliferation Act of 1978 contemplates some return of foreign spent commercial fuel to the United States, but this authority was not used by the Carter administration and shows little signs of being used by the Reagan administration. The United States has only taken back spent fuel containing highly enriched uranium from various research reactors abroad.

TABLE XII.—INFCE: REPROCESSING PLANTS IN OPERATION, 1977

Country and plant	Type of fuel	Capacity (t/a heavy metal)	Throughput (t/a heavy metal)
Belgium:			
Eurochemic	LWR [1]	75	
Dessel-Mol	MTR [2]	1.25	Stand-by since 1974.
France: [3] La Hague HAO	Oxide	Depends on fuel	No French fuel.
Germany, Federal Republic of: WAK	LWR	35	16.
Italy: Pilot plants only	(4)	(4)	(4).
Netherlands			
United Kingdom [3]			
Finland			
Spain: Planta Caliente M-1	MTR	0.3	Closed in 1970.
Sweden			
Switzerland			
Canada			
United States: No industrial plants			
Australia			
Japan: PNC Tokai	LWR	210	(4).
India:			
Trombay	U metal	30	(4).
Tarapur	Oxide	100	Being commissioned.
Mexico			
Philippines			
South Africa			

[1] Enriched to 5 percent or less.
[2] Enriched to 93 percent or less.
[3] Plants for reprocessing spent fuel from natural uranium-fueled gas-cooled reactors are not included.
[4] No data given to INFCE.
t/a = metric tons per year.

Source: Reprocessing, plutonium handling, recycle. Report of Working Group 4. International Nuclear Fuel Cycle Evaluation. Vienna: International Atomic Energy Agency, 1980, p. 273.

Concerning potential alternative suppliers, the International Atomic Energy Agency has established a Committee on International Storage of Spent Fuel, to prepare the way for some kind of international repository. It is too early to say how successful this effort—in which the United States is participating—will be. One indication of potential difficulties to be overcome appears in the hostile reactions by several Pacific countries to United States' discussions with Japan about using an island in the Pacific for storage of Japanese spent fuel.

Conclusion

With the limited exception of enrichment, there are several suppliers for nuclear fuels and technology that could replace the United States. For enrichment, the United States at the moment remains a substantial supplier, but France is quickly expanding its capacity and additional suppliers can be expected in the future unless the United States can discourage new ventures, or channel them into the hands of a global or regional intergovernmental organization.

In a few years, Japan can be expected to be an increasingly competitive new nuclear supplier, but at present the major potential alternative suppliers include Canada, France, the Federal Republic of Germany, Italy, Sweden and the United Kingdom. Of these, France, the Federal Republic of Germany and Italy within the last 3 years have supplied nuclear assistance to India, Iraq, Libya or Pakistan.

ISSUE 6: THE APPLICABILITY OF SECTION 129 OF THE ATOMIC ENERGY ACT AND ITS CONDITIONS FOR TRIGGERING A MORATORIUM ON U.S. NUCLEAR SUPPLY TO NATIONS ASSISTING OTHER COUNTRIES IN ACTIVITIES "HAVING DIRECT SIGNIFICANCE FOR THE MANUFACTURE OR ACQUISITION OF EXPLOSIVE DEVICES"

The following analysis is in two parts. The first is a brief commentary by CRS Senior Specialist, Warren H. Donnelly which looks at the issue from the standpoint of Presidential action. The second is a legal analysis by CRS Senior Specialist, Ray Celada.

COMMENTARY

Section 129 of the Atomic Energy Act, as amended by the Nuclear Non-Proliferation Act of 1978, would cut off exports of nuclear materials and equipment or sensitive nuclear technology to any nation or group of nations if the President finds that one of three situations exist, which are that a nation or group of nations (such as Euratom) have: (1) materially violated an agreement for nuclear cooperation with the United States; or (2) assisted, encouraged, or induced any non-nuclear weapon state to engage in activities involving source or special nuclear material and having "direct significance for the manufacture or acquisition of nuclear explosive devices . . ."; or (3) entered into an agreement for the transfer of reprocessing equipment, materials, or technology to the sovereign control of a non-nuclear weapons state except in connection with an international agreement or understanding to which the U.S. subscribes.

If there are indications that nations may be assisting other countries in activities "having direct significance for the manufacture or acquisition of nuclear explosive devices," the President has several options. In principle he can:

(1) Decide that the activities do not have the direct significance that would require him to make the triggering finding.

(2) Put diplomatic pressure on an offending state by reminding them of this provision and that the activities if continued would cause him to cut off U.S. nuclear assistance.

(3) Make the finding after failing to get the state involved to stop its offending activities, in which case termination would be triggered.

In these cases, the determining factor would be the President's interpretation of how the action of the offending state relates to ". . . activities involving source or special nuclear material and having direct significance for the manufacture or acquisition of nuclear explo-

sive devices . . ." As will be seen in the legal analysis below, the legislative history of the Act provides little instruction as to the meaning of this criterion, which leaves the President free rein for his own interpretation. If there are indications that a state may be involved in activities of this kind, what happens will depend upon the President's interpretation. If he sees the activities as pointing to the finding, he can make it. However, if he makes no finding but temporizes, the Act will not require him to act because it is permissive. Political pressures might be brought to bear, but appeal to the courts probably would be of little help. In short, while the Act enables the President to threaten cut off of U.S. nuclear cooperation to a country that is helping another country to make nuclear weapons, it does not require the President to act. Whether a President could politically ignore information that something undesirable is going on, is another matter which is beyond the ambit of this analysis.

Legal Analysis: Overview

Cut-off of U.S. nuclear cooperation to nations that encourage non-nuclear weapons states to carry on weapons development

The Nuclear Non-Proliferation Act of 1978 (NNPA), Public Law 95–242, 92 Stat. 120 (1978); 42 U.S.C. §§ 2011–2160(a), attempts to balance the competing objectives of cooperation and control. It imposed a series of new controls while it also imparted a new element of stability and predicability to U.S. nuclear relationships.

The NNPA is the first major change since 1954 in the law relating to the terms and conditions of U.S. international peaceful nuclear trade. The Act imposed immediately applicable conditions for the licensing of exports of nuclear material and equipment, established requirements for new and amended agreements for peaceful nuclear cooperation, and announced goals for further negotiation of nonproliferation control.

The key element of U.S. policy is that nuclear cooperation will not be used for any military or nuclear explosive purposes. This limitation manifests itself in the export criteria, 42 U.S.C. 2156(2), in provisions authorizing new and renegotiated agreements for cooperation, 42 U.S.C. 2153(a)(3), and in restrictions on U.S. nuclear cooperation with nations that violate that policy, 42 U.S.C. § 2158.

In connection with the latter, the NNPA provides, inter alia, for termination of U.S. nuclear cooperation with any non-nuclear-weapon state that the President finds has at any time after March 10, 1978 detonated a nuclear explosive device or engaged in activities involving source or special nuclear material having direct significance for the manufacture or acquisition of nuclear explosive devices, and has failed to take steps which, in the President's judgment, represent sufficient progress toward terminating such activities. 42 U.S.C. § 2158(1). The Act further requires, inter alia, termination of U.S. nuclear cooperation with any nation or group of nations, both nuclear and non-nuclear-weapons states, that the President finds has at any time after March 10, 1978 assisted, encouraged or induced any non-nuclear-weapon state to engage in similar kinds of activities and has failed, in the President's judgment, to take sufficient corrective action, 42 U.S.C. § 2158(2).

The President may waive these requirements calling for mandatory termination if he determines that the cessation of exports would be seriously prejudicial to the achievement of U.S. non-proliferation objectives or otherwise jeopardize the common defense and security. Any such waiver must be submitted to the Congress for a period of 60 days of continuous session before it becomes effective and it may be overridden by a concurrent resolution in accordance with congressional review procedures specified by the Act.

Briefly, the NNPA requires the termination of nuclear exports from the United States for engaging in certain kinds of conduct. While the provision is mandatory, its application is dependent upon the President making various determinations. In other words, the mandated sanction of export termination involves the operation of broad Executive discretion. The President has to find that the activity which gives rise to the sanction occurred after March 10, 1978. Also, the President has to find that the party or parties that have engaged in the proscribed activities have failed to take sufficient corrective action. Finally, even if he makes findings consistent with termination, the President may waive the sanction where its application would be contrary to U.S. non-proliferation objectives or at odds with U.S. security.

The provisions of the NNPA relating to conduct resulting in termination of nuclear exports received relatively little attention during congressional deliberations on the Act. The only apparent substantial question that seems obvious at this time is whether "activities involveing source material or special nuclear material" require the United States to terminate nuclear cooperation because a recipient country engages in civil reprocessing; a matter addressed in a previous memorandum.

While the legislative history of the NNPA insofar as the mentioned provisions are concerned is relatively meager, the Senate Report (No. 95-467) makes three points relevant to these matters.

> The Fourth point in subsection 129(a)(1) [42 U.S.C. § 2158(1)(D)], concerning explosives development has been narrowly drafted in order to distinguish between general scientific activities and those which are intended for explosives development. Thus, it only applies to activities actually involving nuclear material, and to those activities having direct significance for bomb development.
>
> Moreover, the President might become aware of activities which may or may not be at the state of utilizing nuclear materials but which are clearly related to nuclear explosives research or development. The President should not refrain from imposing sanctions in such an instance solely because it does not fall within the specific scope of these provisions.
>
> The second prohibited act under subsection 129(a)(2) [42 U.S.C. § 2158(2)(B)] would not include activities under Title V of the NPT to conduct a peaceful nuclear explosion for peaceful purposes under tightly controlled and internationally sanctioned circumstances.

Points 1 and 3 add a bit of clarifying detail; the second point underscores the ambit of Presidential discretion that exists with respect to implementation of the export sanctions in section 129 of the NNPA.

Legal Analysis: Detailed

The applicability of section 129(2)(B) of the Atomic Energy Act (AEA), as amended by section 307 of the Nuclear Nonproliferation Act of 1978 (NNPA), 42 U.S.C. § 2158(2)(B), and the conditions for

triggering a moratorium on U.S. nuclear supply to nations assisting other countries in activities "having direct significance for the manufacture or acquisition of nuclear explosive devices."

PROVISIONS FOR TERMINATION AND THEIR CRITERIA

The NNPA, Public Law 95-242, 90 Stat. 120 (1978); 22 U.S.C. §§ 3201–3282 and 42 U.S.C. §§ 2011–2160a, was intended to reconcile two seemingly competing objectives; first, to assure U.S. cooperation in worldwide efforts to develop nuclear technology for peaceful purposes; second, to minimize the risk associated with such development, specifically the proliferation of nuclear explosive devices or the capability to make or acquire such devices. Insofar as the second objective is concerned, the NNPA, among other things, strengthened U.S. control over its exports of nuclear fuels, facilities, components, and technology. In particular Title III of the Act contains eight sections relating to procedures, criteria, organization, and jurisdiction for federal control of U.S. exports. Section 129, 42 U.S.C. § 2158, sets out various export termination criteria. Of special significance for present purposes is clause (2)(B) which mandates termination of nuclear exports from the United States to any nation or group of nations which assist, encourage, or induce any non-nuclear-weapon state to engage in activities involving source or special nuclear material which would have direct significance for manufacture or acquisition of nuclear explosive devices and failure to take steps which the President finds represents sufficient progress toward terminating such assistance, encouragement or inducement.

Interest in this particular export termination criterion is prompted by congressional concern "regarding the dangers of nuclear proliferation in several key nations of the Middle East and South Asia, including Iraq and Pakistan." 127 Cong. Rec. S2236 (daily ed. March 17, 1981). Fueling this concern is the prospect of unstable and radical regimes in these regions of the world producing or coming into possession of nuclear weapons.

It has been asserted that certain European suppliers have provided the mentioned countries with the "hardware and dual-use technology" which have enabled the latter to develop reprocessing and enrichment plants "which could also be used in weapons production." Ibid. Accordingly, it has been suggested that the United States can retaliate against supplier states which still rely on the United States for significant amounts of nuclear fuel and hardware under clause (2)(B) by terminating export of such material to the supplier states. Whether the criterion for mandatory export termination to the alleged supplier states is satisfied by the circumstances under consideration is uncertain. There is no hard and fast evidence that the alleged development of reprocessing and enrichment plants are intended for explosive development. Moreover, notwithstanding a lengthy definitions section, e.g., 42 U.S.C. § 2011, and the protracted legislative history associated with the NNPA, the phrase "having direct significance for the manufacture or acquisition of nuclear explosive devices" does not appear to have been subject to extensive scrutiny. As will be seen shortly, available evidence suggests that the export termination criterion contained

in clause (2)(B) seems of doubtful relevance with respect to civil reprocessing and that aforementioned phrase applies to activities involving nuclear material that have "direct" significance for explosives development.

As indicated, clause (2)(B) provides for termination of U.S. exports of nuclear materials and equipment or sensitive nuclear technology to any nation or group of nations that the President finds has assisted, encouraged or induced any non-nuclear-weapon state to engage in activities involving source or special nuclear material having direct significance for the manufacture or acquisition of nuclear explosive devices without having taken steps which the President finds represents sufficient progress toward terminating such assistance, encouragement or inducement. However, the President may waive the sanction if he determines that cessation of exports would be seriously prejudicial to the achievement of U.S. nonproliferation objectives or otherwise jeopardize the common defense and security. The waiver must be submitted to the Congress of a period of 60 days of continuous session during which time it can be prevented from going into effect by passage of a concurrent resolution.

It should be noted that export termination criteria in subsection (2), unlike those of subsection (1) of section 129, apply to any nation or group of nations, whether or not a non-nuclear weapon state. Senate Report No. 95–467 at 18.

The assistance, encouragement, or inducement by a nation or group of nations which is an essential element for application of the clause (2)(B) termination must involve "source or special nuclear material." These terms are defined by section 11 of the AEA, as amended, 42 U.S.C. § 2014 and, respectively, include, for example uranium ore and enriched uranium. Moreover the clause requires that the activities involving these materials must have "direct significance for the manufacture or acquisition of nuclear explosive devices."

Do these provisions mandate termination in the case of a recipient country which engaged in reprocessing activities for civil purposes? Various arguments can be made that they do not.

To begin with, clause (2)(C) of section 129, 42 U.S.C. § 2158(2)(C), expressly deals with reprocessing transfers as a separate prohibited act. As such, it prohibits, on pain of loss of U.S. cooperation, any nation or group of nations from entering into an agreement after March 18, 1978 to transfer reprocessing equipment, material technology to the sovereign control of a non-nuclear-weapon state except in connection with an international fuel cycle evaluation in which the U.S. participates or pursuant to a subsequent international arrangement to which the United States subscribes. The legislative hisory of NNPA does not seem to offer any support for the view that the two clauses in question were intended or had the effect of such overlapping or duplicative coverage.

More significant, perhaps, is the view expressed in the Senate Report regarding the same phrase—i.e., "engaging in activities involving source or special nuclear material having direct significance for the manufacture or acquisition of nuclear explosive devices" as it appears in section 129(1)(D) concerning explosive developments. The report states that that phraseology "has been very narrowly

drafted in order to distinguish between general scientific activities and those which really are intended for explosive development. Thus, this only applies to activities actually involving nuclear material, and to those activities having direct significance for bomb development. Senate Report No. 95–467 at 19. (Emphasis in original.)

Two other points are made by the Senate Report with respect to clauses (2) (B) and (C). It states:

> The second prohibited act under section 129(a)(2) would not include activities under Title V of the [Non-Proliferation Treaty] to conduct a peaceful nuclear explosion under tightly controlled and international circumstances. In addition the third point concerning the transfer of reprocessing would not extend to common industrial items which are not otherwise restricted. Ibid.

Although the foregoing reasons seem to indicate that the prohibited act under clause (2)(B) would not include activities relating to civil reprocessing the Senate Report indicates that the President has discretion to terminate nuclear exports although the objects of his concern are not specifically denounced as prohibited acts by section 129. It states:

> . . . the President might become aware of activities which may or may not be at the state of utilizing nuclear materials but which are clearly related to nuclear explosives research or development. The President should not refrain from imposing sanctions in such an instance solely because it does not fall within the specific scope of these provisions. Senate Report No. 95–467 at 19.

THE ROLE OF THE PRESIDENT

It is clear that the NNPA lodges rather broad discretion in the President with respect to the imposition of export sanctions. He is charged with making the crucial findings that trigger their application. Initially he must find that a violation has occurred. Then, before the mandated sanctions become effective, he has to find that the violating nation or group of nations has failed to take corrective action. Indeed, the committee report on the legislation indicates that his discretion is broader than appears on the face of the NNPA. He is encouraged to cutoff exports even though the activities leading to such a drastic step are not expressly condemned by the law. The only express check on the President's discretion comes into play if he makes the requisite findings but decides to waive export controls in the interest of U.S. non-proliferation objectives or in the interest of common defense and security. The exercise of this waiver authority is subject to reversal by congressional passage of a concurrent resolution.

As the Act presently stands, there appears to be little or no way to directly force the President to make the findings necessary to impose export sanctions in a particular case. There is no express provision for judicial relief in this regard. It is doubtful that either private persons or congressional persons possess standing to sue to challenge a presidential refusal to take those steps that are essential to stop exports of nuclear materials and equipment. (Standing requires that a complainant must demonstrate a particular, personal injury which can be redressed by the courts.) Moreover, litigation undertaken to compel performance of a discretionary act, as distinguished from a ministerial act—one in which no discretion is involved—seems out of the question. Cf. *Kendall* v. *United States ex rel. Stokes*, 37 U.S. (12

Pet.) 524 (1834). Finally, the American judiciary has long recognized that it should leave foreign affairs matters to the political branches of government. Elaborating on the necessity of judicial abstinance in the conduct of foreign relations, Justice Jackson declared for the Court:

> The President, both as Commander in Chief and as the Nation's organ for foreign affairs, has available intelligence services whose reports are not and ought not to be published to the world. It would be intolerable that courts, without the relevant information, should review and perhaps nullify actions of the Executive taken on information properly held secret. Nor can courts sit in camera in order to be taken into executive confidences. But even if courts could require full disclosure, the very nature of executive decisions as to foreign policy is political, not judicial. Such decisions are wholly confided by our Constitution on the political departments of the government, Executive and Legislative. They are delicate, complex, and involve large elements of prophecy. They are and should be undertaken only by those directly responsible to the people whose welfare they advance or imperil. They are decisions of a kind for which the Judiciary has neither aptitude, facilities nor responsibility and which has long been held to belong in the domain of political power not subject to judicial intrusion or inquiry. *Chicago & S. Air Lines* v. *Waterman S.S. Corp.*, 333 U.S. 103, 111 (1948).

OPTIONS FOR CONGRESS

In the absence of an amendment to the NNPA so that export sanctions follow automatically upon a violation (e.g., prohibitions on military assistance and sales for unauthorized use formerly operated this way), Congress has a number of options open to it. Of course, Congress can by law prohibit nuclear exports to a particular nation or group of nations. Thus, when Congress and the President were at odds over arms transfers to Turkey because of the latter's activities in Cyprus, Congress amended the Foreign Assistance Act of 1961, as amended, to halt such transfers. Also, Congress can withhold action on an unrelated presidential request until he takes action in line with congressional desires. During the Nixon administration, for example, the Senate refused to act on a cabinet post nomination until the President dropped his claim of executive privilege in connection with desired testimony by a White House staffer on the controversial ITT affair. Informal political pressure by the membership can also persuade an administration to change its policies as evidenced by the reversal of threatened fund cutoff to Chicago in the 1960's for alleged discriminatory educational policies. Briefly, some action along the mentioned lines, rather than litigation, may have to be pursued to force the President to take those steps necessary to impose export sanctions for an asserted violation of the NNPA.

APPENDIXES

Appendix A: Non-Proliferation Profiles For India, Iraq, Libya, and Pakistan

INDIA

Year of operation of first power reactor: 1969.
Number of power reactors 1980: 8.[1]
Dominant reactor type: PHWR.
Total potential output of power reactors (net MWe) 1980: 1684.
Total realized output of power reactors (net MWe) 1980: 860.[2]
Approximate annual production of plutonium (kg) 1980: 220.
Approximate accumulated stock of plutonium (kg) 1979: 1,139.
Approximate accumulated stock of plutonium (kg) 1984: 2,531.
Year of operation of 1st research reactor: 1956.
Number of research reactors in operation 1980: 4 (and 1 under construction[3]).
Breeder reactor developments: 30 MWe experimental breeder under construction.
Uranium resources. Some uranium, substantial thorium.
Reprocessing facilities: 30 ton-per-year (tpy) Trombay facility at the Bhabha Atomic Research Center; 100 tpy Tarapur plant; 100 tpy Kalpakalm plant in progress.[4]
Member of IAEA.
NPT Status: Not a member.
Non-NPT safeguards agreement signed with IAEA.
Military expenditure 1980: $3,605,000,000.[5]
Potentially nuclear capable delivery systems: Aircraft—78 Canberra; 16 Jaguar; 252 MiG 21. Missiles—SLV-3.

IRAQ

Number of power reactors 1980: 1.[6]
Total potential output of power reactors (net MWe) 1980: 900.
Total realized output of power reactors (net MWe) 1980: 0.
Dominant reactor type: PWR.
Year of operation of 1st research reactor: 1968.
Number of research reactors in operation 1980: 1 (and 1 under construction).

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[1] Operable, under construction, or on order (30 MWe and over) as of Dec. 31, 1980. Below, potential output refers to output expected when all power reactors under construction and under order in 1980 are activated; realized output refers, of course, to output in 1980.
[2] Nucleonics Week, Jan. 22, 1981, p. 3.
[3] Nuclear News, February 1981, p. 66.
[4] Wall Street Journal, Apr. 20, 1981, p. 22.
[5] 1978 prices/exchange rates.
[6] See note 1.

Member of IAEA.
NPT status: Ratified.
NPT safeguards agreement in force.
Military expenditure 1979: $2,440,000,000.[7]
Potentially nuclear-capable delivery systems: Aircraft—12 Tu–22; 10 Il–28; 80 MiG–23B. Missiles—$_{12}$Scud-B SSM, $_{26}$FROG–7.[8]

LIBYA

Number of power reactors 1980: 1.[9]
Total potential output of power reactors (net MWe) 1980: 440.[10]
Total realized output of power reactors (net MWe): 1980: 0
Dominant reactor type: PWR.
Uranium resources: Nominal.
NPT status: Member.
NPT safeguards agreement in force.
Military expenditure 1977: $1,579,000,000.[11]
Potentially nuclear-capable delivery systems:
Aircraft—17 Tu–22; 100 MiG–23; 35 MiG–25; 20 MiG 21; 50 Mirage III; 7 C–130H; 1 Boeing 707; 1 Il–76. Missiles—$_{30}$Scud-B SSM 12 FROG–7.[12]

PAKISTAN

Year of operation of 1st power reactor: 1971.
Number of power reactors 1980: 1.[13]
Dominant reactor type: PHWR.
Total potential output of power reactors (net MWe) 1980: 125.
Total realized output of power reactors (net MWe) 1980: 125.
Approximate annual production of plutonium (kg) 1980: 30.
Approximate accumulated stock of plutonium (kg) 1979: 201.
Approximate accumulated stock of plutonium (kg) 1984: 605.
Year of operation of 1st research reactor: 1965.
Number of research reactors in operation 1974: 1.
Reprocessing facilities: small-scale plant in construction; construction of commercial-scale plant interrupted.
Enriched facilities: Centrifuge enrichment plant in construction.
Uranium resources: Nominal.
Member of IAEA.
NPT Status: Not a member.
Non-NPT safeguards agreement signed with IAEA.
Military expenditure 1979: $1,001,000,000.[14]
Potentially nuclear-capable delivery systems: Aircraft: 11 Canberra; 10 Mirage IIIRP; 17 Mirage III; 38 Mirage V; 140 MiG–19; 14 C–130.

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[7] See note 5.
[8] See Henry S. Rowen and Richard Brody, "The Middle East," in Nonproliferation and U.S. Foreign Policy, ed. by Joseph A. Yager, (Washington, D.C.: The Brookings Institution, 1980), p. 231.
[9] See note 1.
[10] Nuclear News, February 1981, p. 81, gives 300 MWe and other sources give 400 MWe, but the Libyan contract is with the U.S.S.R., which imports 440 MWe reactors.
[11] See note 5, SIPRI estimate.
[12] See Rowen and Brody, p. 231.
[13] See note 1.
[14] See note 5, 1980 SIPRI estimate: $1,068,000,000.

NOTES

Source: Nuclear Fuels Policy: Report of the Atlantic Council's Nuclear Fuels Policy Working Group (Washington, 1979).

Power reactor information updated with World List of Nuclear Power Plants, Nuclear News, February 1981. Military expenditure figures from World Armaments and Disarmament: SIPRI Yearbook 1981 (London, 1981). Aircraft and missiles from International Institute of Strategic Studies' Military Balance 1980–81 (London, 1981). Accumulated stocks of plutonium from OTA estimates in Nuclear Proliferation and Safeguards. Appendix Volume 11, part 1 (Washington, 1977).

Appendix B: Discussion of Enrollment Data on Foreign Nationals From India and Pakistan in Engineering or Physics Programs in the United States and Western Europe

Information concerning the enrollments of foreign nationals from India, Iraq, or Pakistan in physics or engineering programs in the United States and Western Europe is not being collected (except on a limited basis by the National Science Foundation) by agencies within the Federal Government. Other non-Federal organizations which collect student enrollment data, such as the Institute for International Education of United National Educational, Scientific, and Cultural Organization (UNESCO), also are not collecting such data. A recent General Accounting Office (GAO) report which examined enrollments of foreign nationals in nuclear programs, does not compile statistics on enrollments by nationality.[1] The GAO report did not discuss other related data collected by other agencies.

The Immigration and Naturalization which is another potential source of information on the proposed course of study for student visa applicants. The service requires only that an applicant show a certificate of eligibility, have adequate financial resources, and intend to leave the United States upon completing his or her studies.

The National Science Foundation (NSF) does collect data on the nationality of recipients of doctoral degrees granted by American universities by field of study; they do not collect data on enrollments for any other level of study. The NSF also does not publish information concerning doctoral recipients by nationality, but upon request, will prepare the information at cost.

The NSF was able to provide us with information concerning the number of doctoral degrees granted to foreign nationals in the fields of physics and engineering based upon information prepared for Brookhaven National Laboratory in 1979. This information, as listed in table I shows that about 3,490 degrees were granted to Indian, Iraqi, and Pakistani nationals between 1958 and 1976, of which 92 percent were granted to foreign nationals from India.

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[1] "Difficulties In Determining If Nuclear Training Of Foreigners Contributes to Weapons Proliferation," GAO, ID 79–2.

TABLE I.—NUMBER OF DOCTORAL DEGREES GRANTED TO FOREIGN NATIONALS FROM INDIA, IRAQ, AND PAKISTAN IN PHYSICS AND ENGINEERING (1958–76)

	Engineering		Physics	
	1958–76	1976 only	1958–76	1976 only
India	2,492	214	652	43
Iraq	89	1	12	0
Pakistan	130	14	40	4
Total	2,711	(229)	704	(47)

There are hundreds of programs in physics and engineering offered in the United States and Western Europe. There are no reports available, however, which evaluate the relative quality of the programs.

We were not able to obtain detailed information concerning the availability of such programs in India, Iraq, or Pakistan either from published materials, the embassies of those countries, or the Arab Information Office.